

**ANGLIA RUSKIN UNIVERSITY**

**Enhancing Quality of Life Through Aquatics Therapy:**

EFFECTIVENESS OF ADAPTATION OF SEATING POSTURE LOADING  
IN A PARTIALLY IMMERSED AQUATICS THERAPY APPROACH FOR THE IMPROVED  
FUNCTIONING AND PERCEIVED COMPETENCE OF CHILDREN WITH CEREBRAL PALSY,  
AS REFLECTED IN THEIR QUALITY OF LIFE:  
A MULTIPLE CASE STUDY

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A thesis submitted in partial fulfilment of the requirements of Anglia Ruskin  
University for the degree of Doctor of Philosophy

**Submitted: 2010**

*This work is dedicated to my parents*

***Shmuel and Nurit***

*'Yivadu Lechaim Arukim', 'May you Live Long and Well'.*

*Your continual unconditional support,  
the wonderful education and care that you granted me in all fields of my life  
pointed me so successfully to the path of achieving this PhD -*

***Thank you.***

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*To Wickedness the Road is quickly found.  
Short is the Way, and on an easy Ground:  
The Paths of Virtue must be reach'd by Toil,  
Arduous, and long, and on a rugged Soil,  
Thorny the Gate, but when the Top you gain,  
Fair is the future, and the Prospect plain.*

### **Works and Days**

Hesiod, Book I: Line 375

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ANGLIA RUSKIN UNIVERSITY  
ABSTRACT

SCHOOL OF EDUCATION

PH.D.

**ENHANCING QUALITY OF LIFE THROUGH AQUATICS THERAPY:  
EFFECTIVENESS OF ADAPTATION OF SEATING POSTURE LOADING IN A PARTIALLY IMMERSSED  
AQUATICS THERAPY APPROACH FOR THE IMPROVED FUNCTIONING AND PERCEIVED COMPETENCE OF  
CHILDREN WITH CEREBRAL PALSY, AS REFLECTED IN THEIR QUALITY OF LIFE:  
A MULTIPLE CASE STUDY**

**BY ARIE NIV SHELEF  
2010**

An innovative Partially Immersed Approach, based on mixed principles of land and aquatic therapy theories was developed to enhance sitting adaptation and functioning in an Aquatics Therapy environment, thus improving quality of life for children with Cerebral Palsy. The Approach aimed to enhance motor adaptation, engendering adaptation in psychosocial domains of quality of life. It employed a specially-developed therapeutic treatment chair, in an unloading toward loading strategy, to regulate and control percentage of weight-bearing by manipulation of buoyancy (Archimedes principle) and gradually reduced immersion in a series of 30 mm steps (a scale not previously mentioned in the literature). The approach with the chair underlying conceptual framework of the research that emphasised the paradigm of improves adaptation as the basis for improved quality of life. The study focused on the examination of the validity and effectiveness of the new Approach. Research methods included: Focused Interviews, Goniometry, Sitting Assessment for Children with Neuromotor Dysfunction, Rating Scale Activities of Daily Living Observation Test, Interval Recording Observation, Gross Motor Function Measure and Pictorial Scale of Perceived Competence in Israeli Children with CP. Participants were bilateral spastic hypertonia, Cerebral Palsy children, aged 10-15 years. Mixed-methods methodology was used to investigate effectiveness of treatment, employing a small sample in a multiple case study (n-5 in four cases). Data obtained from quantitative and qualitative tools were reinforced by triangulation. Each case was tested at pre-treatment, post-treatment (Stages 1 and 2) and at a 12-month follow-up point.

The improved physical abilities also engendered enhanced adaptation, confidence and success, expressed in psychosocial domains: perceived competence, empowerment and motivation, thus improving the children's quality of life, an improvement sustained at a one year post-intervention test. Quantitative findings of this study demonstrated that water treatments achieved the most efficient intervention results the combined water and land treatments achieved top results while land only intervention achieved the lowest results.

Qualitative findings indicate that all participants experienced a significant improvement on land in free sitting on stool, activity in daily living, hand-head coordination for functioning skills, and a significant improvement in competence and quality of life.

In conclusion the developed approach regulated the percentage of weight bearing by manipulating buoyancy in gradual 30 mm steps of immersion, starting with aquatic unloading toward gravity loading. These processes transfer improved water adaptation to the land environment, enabling aquatic therapy to be employed to improve motor function adaptation on land and consequently enhancing adaptation in other psychosocial domains, thus improving quality of life for children with Cerebral Palsy, sustained at a 12 month follow-up. The new approach may employed to improve adaptation of other disabilities and with other gross motor skills, perhaps necessitating modified other treatment tool. These findings may contribute knowledge to theories of motor control and learning, dynamic systems and ecological approach, by identifying the trigger cause for systems' change, thus controlling immersion conditions to enhance adaptation, feed-forward and add to information processing theory by combining three models to enable a more holistic conceptualisation of the influence of improved (buoyancy regulated) extrinsic adaptation on the child's intrinsic systems.

## ABBREVIATIONS USED IN THE THESIS

ADL	Activities of Daily Living
ADLSF	Activities of Daily Living Skill Function
AST	Association of Swimming Therapy
AT	Aquatic Therapy
BBM	Black Box Model
BRRM	Bad Ragaz Ring Method
C	Celsius
c	Control participant
CA	Conductor's Assistant
CE	Conductive Education
CNS	Central Nervous System
CP	Cerebral Palsy
DST	Dynamic System Theory
EA	Ecological Approach
FCS	Family Centred Services
GMFM	Gross Motor Function Measure Manual
GMFCS	Gross Motor Function Classification System
GSW	Global Self-Worth
HA	Halliwick Approach
HHC	Hand-Head Coordination
HRQOL	Health Related Quality Of Life
ICF-CY	International Classification of Functioning-Children and Youth Version
ICIDH	International Classification of Impairments, Disabilities and Handicaps
IPT	Information Processing Theory
IRO	Interval Recording Observation
JBED	Jerusalem Board of Education District
MCLT	Motor Control and Learning Theories
mm.	millimetre
MMD	Mixed Methods Design
MP	Movement and Posture
NDFI	Non-Directive Focused Interviews
NDT	Neurodevelopmental Therapy
PAT	Pediatric Aquatics Therapy
PC	Perceived Competence
PIA	Partial Immersion Approach
PNF	Proprioceptive Neuromuscular Facilitation
PSE	Perceived Self Efficacy

PSPCICCP	Pictorial Scale of Perceived Competence in Israeli Children with CP
QOL	Quality Of Life
RCPWB	Regulate and Control Percentage of Weight Bearing
ROM	Range Of Motion
RQ	Research Questions
RSADLOT	Rating Scale for ADL Observation Test
SACND	Sitting Assessment for Children with Neuromotor Dysfunction
SCT	Social Cognitive Theory
SPT	Strength Posture of the Trunk
TTC	Therapeutic Treatment Chair
TTTA	Task Type Training Approach
WA	Watsu Approach
WHO	World Health Organization

## *Prologue*

Darwin, in *Power of Movement in Plants* (1880) argues that all plants have fundamental revolving movement '*... in relation to light, food, and gravitation. In short, like animals, plants move in order to live, though they move with invisible slowness*' (Irvine, 1955, p.205).

The Bobaths (1984; 1985) applied animals' neuro-physiological tonal phenomena to humans by adopting the concept of the phenomenon of sustained muscular contraction (Magnus, 1926). This phenomenon plays a significant role in maintaining posture against gravity enabling the animal to support itself against the gravity force when it is unable to maintain balance.

Yet,

*Even stable aspects of behavior are 'softly' assembled so that different aspects of motor behavior (i.e., need for greater stability of variability of movement against the force of gravity) vary in response to changes in adaptive value as the infant develops* (Howle, 2004, p.23).

The quotations given above provide an appropriate starting point for this study. What Darwin, the Bobaths, Magnus and Howle wished to explain was that we should understand the immense impact of gravity on fauna and flora in this world and its effects on behaviour and development; i.e. extrinsic environment effects on intrinsic-organism systems.

The water environment of buoyancy-Archimedes principle and gravity (Appendix 1) - was introduced to me in my kibbutz pool in my early life – at the age of three. Physical and water activity were always better for me than cognitive work that demanded concentration. I chose to rehabilitate children with Cerebral Palsy (CP) due to their vulnerability in childhood and my identification with their weakness, since I have a major learning disability that influences some of my cognitive ability: problems in the realms of attention and concentration (Einat, 1984; Ta'ir, 2000; Cohen-Zmora, 2007). For this reason, the issue of children with CP, a challenging human phenomenon, inspired me, the researcher, as a field for discovery.

The idea of using buoyancy and gravitational forces to rehabilitate sitting posture in children with CP has intrigued me since my teacher training studies (1982) and especially when I performed AT rehabilitation training for army patients. Nine years (1985-1994) in Ontario, Canada working with dual-diagnosed psychotic youth in a pool with a hydraulic floor (Lepore, Gayle and Stevens, 1998; Fragala-Pinkham, Dumas, Barlow and Pasternak, 2009), enhanced my idea of developing a Therapeutic Treatment Chair (TTC- a specially developed chair for use in water, Appendix 2).



During the years when I conducted Aquatics Therapy (AT) with children with CP, and to further the notion of an improved TTC, I carried out a pilot study (Appendix 3) (Shelef, 2002), to verify my assumptions. At that time, I had no idea how I would raise the chair, with the participant, above the water line. Walking in the streets of Jerusalem, the interlocking stone pavement inspired me with the idea of using these stones to raise the chair out of the water. The dimensions of the stones were perfect for my needs. I used the stones under the chair legs to gradually raise the participant out of the water while exercising. At the end of the 16 treatment sessions, the water line was level with the hip joint and the participant with CP had increased his time of free-independent sitting as well as his posture and balance.

Hutzler (2009) suggests that in the future training for children with CP will tend to emphasise lightening of body weight. According to Harrison, Hillman and Bulstrode (1992), in the AT Partial Immersion Approach (PIA - based on controlling immersion in water included combination of approaches parts between water and land environments) *'the percentage [of] immersion is the depth of immersion against the subject's height'* (p.165). My goal in rehabilitation is to test the PIA in combination with TTC, to investigate whether this technique can contribute to the Quality of Life (QOL) of children with CP.

Reflecting on this journey I was fascinated by an understanding that I developed: *'physical adaptation engenders adaptation in other domains'*, a phrase which I take with me to my teaching of physical education in special education settings and as an educator. This is the concept that reflects and validates my personal experiences and insights. This 'slogan' is applied in my personal life, motivation (Lipscher, 2009), teaching, and in my personal view of rehabilitation. It has universal application for behaviour and I would therefore like to share it with others including challenged populations. In this sense, my journey of discovery described in these pages is relevant for me both as a father, teacher, educator, therapist and as a member of my society.

## CHAPTER ONE: INTRODUCTION

This chapter introduces the aim and focus of the research, and the research objectives. It describes the personal and academic context of the research and the main issues examined by the research, starting from the issue of adaptation to the environment, describing different types of environments, then explaining AT and different treatment approaches. It indicates how and why the methodology was selected and how the research adds to extant knowledge. Finally it outlines the research process and presents the Research Questions (RQ).

The focal issue of this research is human adaptation to the environment (Van Eck, Dallmeijer, Voorman and Becher, 2009). Most species have adapted to their environment (Romanes, 1895; Darwin, 1958), but the Neurodevelopmental Therapy (NDT) and Conductive Education (CE) approaches suggest that people with CP are maladapted to their environment, specifically, finding it difficult to adapt to gravity. A connotation of gravity is also reflected in the definitions of CP by Rosenbaum, Paneth, Leviton, Goldstein and Bax (2007a), stating that CP is '*a group of permanent disorders...of movement and posture*' (p.9.). Movement-and-Posture (MP) are also explained by Bobath (1967b; 1971a, c;1972; Howle, 2004), as '*activity against gravity*' (Bobath, 1984, p.7), which, in Peto's view, relates to a '*gravity point*' (Maguire and Nanton, 2005, p.26).

The present inquiry aimed to test-confirm a new form of PIA. This approach is based on the assumption that one of the options for the rehabilitation of people with CP uses a force opposing the force of gravity to help these people to adapt to the dictates of the law of gravity on land. This is the 'law of buoyancy' – 'Archimedes principle': '*Buoyant force is equal to the weight of the fluid displaced ... This effect may be of great therapeutic utility*' (Becker, 2004, pp. 23-24).

Motor behaviour is enhanced by structuring the child's environment (VanSant, 2003) since adaptive structures are affected by external conditions (Romanes 1895). According to the World Health Organization (WHO, 2007), the term 'environment' refers

*...to all aspects of the external or extrinsic world that form the context of an individual's life and, as such, have an impact on that person's functioning. Environmental factors include the physical world and its features, the human-made physical world, other people in different relationships and roles, attitudes and values, social systems and services, and policies, rules and laws' (p.229).*

These external conditions constituted the work environments (land and water) for the research.

Six studies verifying the benefits of AT environment for children with CP and focusing on the increase of the Range Of Motion (ROM)-flexibility reinforced the researcher's choice of topic. These studies were all based on the assumption that rehabilitation through AT activities can benefit land activities (Becker and Garrett, 2004; Petersen, 2004; Vargas, 2004). This view contradicts the opinion of McAvoy (2006) that *'water works best for certain things and land works best for others'* (p.3).

Since one of the basic components of functional behaviour is motion, including the individual's ROM, the researcher studied the work of Peganoff (1984), Appendix 4: Shelef (1998; 2000), Shelef (2002), Thorpe, Reilly and Case (2005), and Fragala-Pinkham et al. (2009). These sources strengthened the researcher's conclusion that AT used to improve motion and develop ROM would be superior to land therapy for children with CP and this conclusion formed the foundation for the integration of environments in the present inquiry.

The chosen research topic reflected the desire to extend the scope and depth of rehabilitation for children with CP by testing and establishing the benefits of the new PIA. This was an attempt to integrate three theoretical viewpoints and two environments of CP rehabilitation: the Western origin NDT (aiming to promote motor control by inhibiting reflexive abnormal movement and facilitating normal movement patterns) and the Eastern European (Hungarian) origin CE (educating the dysfunctional personality, through an adaptive learning process to become an orthofunctional personality and their associated 'land environment' theories combined with AT (*'rehabilitation / habitation to achieve goals of improved physiological, psychological, psychosocial and/or life activity function under the supervision of individuals qualified and competent in its techniques and utilization'*, (Broach and Dattilo, 1996, p.214).

The AT chosen for the study was described by Lambeck, Stanat and Kinnaird, (2004); Morris (2004); Petersen (2004) and Vargas (2004) and includes the following approaches:

1. Halliwick Approach (HA): a sequential strategy that improves swimming for children with disabilities, applies rehabilitation techniques supported by principles of hydrodynamics and body mechanics, based on: water adjustment-adaptation, rotations, control of movement in the water and freedom of movement.
2. Bad Ragaz-Switzerland, Ring Method (BRRM): a collection of water therapeutic techniques using floatation rings with structured patterns' base to enable passive, active, active assistive and resistive water movements. It integrates Proprioceptive Neuromuscular Facilitation (PNF) i.e. therapeutic clinical exercise techniques.

3. Watsu Approach (WA): based on Eastern medicine theory, aims to increase relaxation by applying a floating strategy using static passive stretches, rotational movement, tone-inhibiting, vestibular stimulation and applying structured sequences of passive movements.
4. The Task Type Training Approach (TTTA): a set of principles to help therapists, based on a task-oriented approach, aiming to improve functional positions by adapting functional activities.
5. Pediatric Aquatics Therapy based on a variety of disciplines for children relating to the community, school, family and the child. It works to achieve meaningful goals, on an individual basis to improve functioning in multidisciplinary fields.

## **1.1 The Aim and Focus of the Research**

This research examined the effects of the implementation of a multivariable PIA using various theories, approaches, principles, systems, models, and a specially designed tool (TTC), integrating AT-water and land environments.

Sitting is the posture that enables humans to function and adapt between the two basic antigravity positions: lying and standing (Bobath, 1967; Reid, 1997). Humans need to be able to sit in their environment on a daily basis in order to adapt and function (Ahl, Johansson, Granat and Carlberg, 2005). This particular activity was therefore chosen as the focus for the present study. The supposition was that the child with CP might acquire and improve sitting skills with AT treatment, by developing and performing sitting skills on a daily basis, thus, accelerating the rate of motor skill acquisition with a cumulative effect, until it became part of the child's repertoire (Gentile, 1987; Schmidt, 1988; Bower, McLellan, Arney and Campbell, 1996; Dean and Shepherd, 1997; Carr and Shepherd, 1998; Trahan and Malouin, 2002).

**The aim was to test the effectiveness of the novel PIA, designed to rehabilitate sitting using a strategy based on the MP of people with CP (Bax, 1964; Rosenbaum et al., 2007a), including the adaptation process of enhanced motor function (Ben-Pazi, 2009a). It was thought that this improved adaptation might lead to a consequent enhancement of adaptation in other domains, thus improving the QOL for these people.**

### 1.1.1 Research Objectives

1. To use microgravity simulation or weightlessness (Clement, 2004; Toscano, Fubini and Gaia, 2004), or '*reduced gravity condition*' (Miyoshi, Shirota, Yamamoto, Nakazawa and Akai, 2004, p.731), unloading, or '*limited weight-bearing*' (McAvoy, 2006; Fragala-Pinkham et al., 2009), then to Regulate and Control Percentage of Weight Bearing (RCPWB) meaning simply to control body weight, which is defined as '*the maximum measured load against the subject's weight on dry land*' (Harrison et al., 1992, p.165), by gradually increasing loading (Becker, 2004; Liao, Liu, Liu, and Lin, 2007). This technique is employed in a practical-clinical application by developing the TTC to create a new environment at each lift stage, due to an altered buoyancy/ gravity relation for the child. This objective was formed on the basis of knowledge gained in the pilot study.
2. To use the MP strategy to enhance free independent sitting.
3. To develop two treatments interventions: A. Strength Posture of the Trunk (SPT) and B. Activities of Daily Living (ADL), with Skills Function (ADLSF). Both treatments improve sitting on land, using Hand-Head Coordination (HHC) during independent free sitting on land, e.g. bringing food to mouth.
4. To develop motor function adaptation using combined NDT, CE and AT approaches.
5. To broaden the effect of enhanced motor adaptation so that it would enhance adaptation in other domains for example Global Self-Worth (GSW) Perceived Competence (PC) Perceived Self Efficacy (PSE), empowerment and motivation. (These terms are described in detail later in this thesis)
6. To apply and test the 'carry over' principle, i.e. transfer of improved abilities achieved in AT to the land environment.
7. To examine how the PIA might improve the QOL of people with CP.

#### Selection of Methodology to strengthen Reliability and Internal Validity

The researcher adopted multiple case studies employing replication logic, that enhanced reliability and reduced errors and biases (Yin, 2003). Mixed Methods Design (MMD) (Morse and Niehaus, 2009) was used, including testing at different points in time for each case to allow the researcher to perform triangulation 'between methods'; 'investigator' and 'time' triangulations and triangulation of two data sources (Stake, 1995; Denzin, 1970 in Cohen, Manion and Morrison 2000; Patton, 2002; Yin, 2003; 2004; Creswell and Clarke, 2007).

*'The integration of quantitative and qualitative data in a single study is still rather uncommon within health studies...Nevertheless, it is argued that both views are needed to understand human experiences'* (Lofqvist, Nygren, Brandt and Iwarsson, 2008, p.10). *'The more that two (or more!) methods have been integrated into each of these procedures, the stronger the "mix" of methods'* (Yin, 2006, p.46), Combining quantitative and qualitative methods the researcher was able to construct a more holistic picture of the studied phenomenon (Morse and Chung, 2003).

### ***Research Problems***

The researcher needed to cope with certain problematic issues concerning the research design, the practical intervention, CP research phenomena and methods: research in a swimming pool environment is potentially harmful to the participants' safety; a special pool facility was needed with water temperature of 33-35 degrees C (Appendix 5); due to exorbitant cost only a single TTC tool was available; it was impossible to find sufficient children with CP who complied with the high inclusion criteria in one city or under one rehabilitation centre or region thus enforcing the use of a small sample size available (Fragala-Pinkham et al., 2009; Diary: 4<sup>th</sup> June, 2002); research costs were high with no financial assistance available.

Children with CP experience a complexity of problems (McNeill, 2004, Howle, 2004; Scrutton, 2004; Gage, 2004 in Gorton et al., 2009), e.g. low levels of functioning (Rosenbaum et al., 2007a; Liptak, 2008; Hanna et al., 2009). The following studies: Bobath (1974); Bobath and Bobath (1984); Hedges (1988); Scherzer and Tscharnuter (1990); McClenaghan, Thombs and Milner (1992); Menkes 1991, in Reid (1996); Trahan and Malouin (2002); Bower (2004); Damiano (2004); Mayston (2004); Rosenbaum, Palisano, Bartlett, Galuppi and Russell (2008); Fragala-Pinkham et al. (2009) and Gorton et al. (2009) support the claims that diagnosis and assessment of CP involves a variety of conditions and impairments, and there is limited evidence regarding intensity and effectiveness of treatment interventions. These authorities indicate that it is difficult to predict precise outcomes and it is difficult to obtain appropriate measurement tools, since there are many independent variables such as: age, body measurements, motivation, Intelligence Quotient, gender.

All these factors necessitate flexible treatment that is individually adapted making the issue of CP a problematic issue for research. Moreover, there is a view that evaluation of sitting tools need to reexamine current rationales and concepts of seating, considering alternative approaches and methods for clinical evaluation (Reid, Sochaniwskyj and Milner, 1991; Reid, 1995; 1996; 1997).

Thus, *'measuring adaptive seating systems ... [is] complex, with varying opinions; little of it evidence based'* (McDonald and Surtees, 2007, p.1042). This leads to *'designs that are weak on internal validity'* and *'no generalisation can be made'* (Nachmias and Nachmias, 1996, p.147).

A large number of tools are used in the research's combined mixed methods research of data collection and analysis (Creswell, 1994; Yin, 2006; Morse and Niehaus, 2009) using replication to increase concurrent, construct and internal validity (Campbell and Fiske, 1959; Yin, 2003). Interpretation was performed using strategies from both research approaches: quantitative-replication logic, replicating the same study conditions for different cases (Yin, 2003), and qualitative interviews used *'to enhance...explanation of the phenomenon under investigation'* (Morse and Niehaus, 2009, p.19, see Appendix 6: Table 1).

Case study involves certain concerns regarding the reliability and scientific generalisation of the research findings (Yin, 2003). Good research should follow principles of validity, reliability and generalisation (Yin, 1993; Shkedi, 2003; 2005). The researcher followed these guidelines, improving validity by the following strategies: a pilot study conducted before commencing the research, explanation building, multiple sources of evidence were gathered enabling triangulation of data, units of analysis were described in detail, and a chain of evidence (leading from one piece of datum to another) was consistently provided (Yin, 1993; 2003; Shkedi, 2003). Reliability was improved by developing a Multiple Case Studies protocol and providing a rich data base (Appendices and Diary) for self-reflection and also so that readers would be able to review the inquiry procedures and results (Yin, 1984; 1993; 2003; Stamm et al., 2008).

The naturalistic approach to generalisation (Stake, 1995) was adopted for qualitative findings following the view of Denzin and Lincoln (2003) to establish credibility, transferability, dependability and conformability. Generalisation is therefore open to refutation or conformation by the reader (Lincoln and Guba 1985; Shkedi, 2005; Corbin, 2009). Finally, there may be potential for Analytic Generalisation (Glaser and Strauss, 1967; Firestone, 1993) of some limited results to add to theory (Yin, 2003).

From a conceptual perspective this research may extend knowledge in five areas:

1. The confirmation of the innovative PIA in AT. This resulted from experimental testing of the practical application of this rehabilitative conceptualisation, employing a specific specially designed tool, the T<sup>2</sup>TC, for specific needs. History suggests that invention of the wheel as a tool was an additional stage in human adaptation to our environment. In an interview that the researcher held on 4<sup>th</sup> August, 2008, with Professor Kottek (Department of History of Medicine of the Haddasah, Ein Karem Hospital), the professor said: *'A person wishing [to help people] to adapt must develop the*

*technology and resources to create this adaptation'*. In the present context, this means RCPWB at each phase - decreasing immersion, to improve rehabilitation of children with CP and other impairments. Thus, development and application of an innovative tool-TTC may constitute a trigger for improved human adaptation.

2. To '*apply adaptation is to understand one thing from another thing* [this is equal to] *wisdom*' (Kottek, 4<sup>th</sup> August, 2008). Indeed the findings of the present research show that motor adaptation engenders adaptation in other domains. An additional concept demonstrated here is that change in the extrinsic-environment, engenders change in intrinsic systems for children with CP. This entails a psychosocial process, which may help to maintain improvement of QOL (as was shown at a 12 months follow-up), and may consequently increase life expectancy (Moons, Budts and De Geest, 2006). This supports and reinforces previous knowledge in the field of rehabilitation.
3. A further contribution to knowledge is the potential ability of the new PIA technique to improve other motor impairments, and different gross motor skills, by developing appropriate rehabilitation tools in accordance with this model for other neuromuscular impairments or disabilities.
4. Enhancing the children's physical adaptative processes has also proved to be an important strategy in the education field focusing on improving skills, cognition, and psychosocial qualities of the researcher's challenged pupils. The finding that improved physical processes led to improvements in school educational process reinforces existing knowledge in this field.
5. The findings of this research also provide additional evidence and reinforcement for the following existing theories:
  - a. Motor Control and Learning Theories (MCLT), the findings indicated that success in controlling and learning of motor skills achieved in a water environment could be transferred to a land environment. PIA in AT, employing a strategy of RCPWB in a series of 30mm maximum phases. This was found to be an effective means to enhance motor adaptation and feed-forward (the child adjusts the behavioural reaction according to prolonged regulating corrective feedback (with PIA-RCPWB) and can consequently plan a better more successful new motion).



- b. Ecological Approach (EA): the findings demonstrate the effect of different environmental conditions on humans. A water-PIA using unloaded toward loading strategy enabled the researcher to control buoyancy/ gravity conditions and was more effective in facilitating motor development than a land environment subject to full gravity conditions.
- c. Dynamic Systems Theory (DST) the findings indicate that improvement in the subsystem of ADL motor functioning following RCPWB stimulation, triggered improvement in psychosocial behaviour, self-competance and self-perception subsystems. The trigger cause for these improvements was therefore identified as a change in the adaptation of the motor functioning subsystem that affected an improvement in the entire system.
- d. Information Processing Theory (IPT) is based on the recognition that environmental stimuli (example: PIA-RCPWB) produce an effect on internal systems, creating better processing and planning of behavioural responses and leading to improved individual adaptation, which in turn reacts on the environment. In the present case RCPWB constituted a manipulation of the external environment which produced the internal system change. The unique combination of three conceptual models underlying the research: International Classification of Functioning - Children and Youth Version (ICF-CY), Bangma model and White's model, enabled a more holistic conceptualisation of the influence of improved extrinsic adaptation on intrinsic systems of individuals with CP.
- e. The findings may also indicate an extension to The Origin of Species Theory, Darwin's explanation of selection/adaptation-by demonstrating that motor adaptation enhanced by RCPWB leads to improved psychosocial adaptation in other domains.

### **1.1.2 The Personal and Academic Context of the Research**

For the past 25 years, I have taught Physical Education in special education settings in Canada and Israel. This experience exposed the problems that this research wished to solve. Living a life and being a Physical Education teacher are both founded on the motor notion of MP (Bax, 1964), a physical interaction with and adaptation to the environment of gravity, suggesting that without motion influenced by gravity there is no effective existence for man. Most scholars who have investigated human motion mention gravity as an important variable (Rood, 1956; Bobath, 1984; Thelen and Spencer, 1998; Morris, 2004; Howle, 2004;

Zaino and McCoy, 2008; Gorton et al., 2009). Most of them agree with its significance but do not aim to RCPWB gravity or manipulate it. The present research demonstrates that when gravity conditions are reduced (Farley and McMahon, 1992; Griffin, Tolani, and Kram, 1999), and load is regulated by PIA people with CP are enabled to enhance their adaptation processes. This concept delineates firm work-boundaries for the research, an attempt to improve adaptation of children with CP despite the fact that they exhibit a lack of adaptive abilities (Bobath and Bobath, 1984; Hari and Akos 1988; Howle, 2004; Damiano, 2006; Rosenbaum, Capelovitch and Sutton, 2007). The paradox is that, although gravity affects MP and therefore adaptation to the environment, there is a lack of research evidence on achievement of buoyancy by unloading human weight in the context of therapeutic work with children with CP in AT.

The present study aims to RCPWB in an AT environment and to examine whether the positive physical results of this process are also effective in improving the QOL of people with CP.

### **1.1.3 Main Issues Examined in the Research**

A child who has CP has reduced ability to right him/her-self against gravity (correction to the proper position of head and body) and the child's sitting posture, trunk and head control affect the child's (proximal-close) postural control and balance while sitting (Bobath, 1971c; Reid, 1995; Preston, 2001; Rosenbaum et al., 2008). The children are then unable to use their hands for functions or for (distal-distant) manipulation of skills (Scherzer and, Tscharnuter 1990; Brogren, Forssberg and Hadders-Algra 2001; Rosenbaum et al., 2008). To solve the problem one needs to develop free sitting ability so that the child with CP *'will have sufficient balance in sitting to use his hands freely ... and is prepared to reach out for objects, for grasp and release'* (Bobath and Finnie, 1958a, p.3).

This study assumes that gravity plays a central role in environment adaptation suggesting that if an organism exhibits difficulty, one option is *'devising new environmental challenges that will require the children to push their abilities farther in order to teach them more adaptability for the variety of environmental demands'*, (Zaino and McCoy, 2008, p.136). Thus, it is time to look for other environment enhancement options e.g. water-AT.

The Bible (Orenstein, 1981) relates to water in different contexts: immersion to purify people (Exodus, 29: 4), water as the source of life (Genesis, 26:19) and water as therapy (Ezekiel, 47: 8-9). While, in the literature many scholars suggest the benefits of AT-water environment (Appendix 7: AT versus Hydrotherapy), to help people with disabilities (Koury, 1996; Morris, 1997; Campion, 1998e; Vargas, 2004), more focus is given to the benefits for people with CP (Dorval, Tetreault and Caron, 1996; Hutzler, Chacham, Bergman and Szeinberg, 1998a; Getz, Hutzler and Vermeer, 2007).

Despite the theoretical benefits of aquatic exercise for children with CP, little research has been conducted on the effect of physical activities in water (Hutzler et al., 1998a; Dumas and Francesconi, 2001; Kelly and Darrah, 2005).

#### **1.1.4 The Research Process**

The research process lasted from April 2002 to January 21, 2007. It took place in the Tamar special school for children with neuromotor impairments in the Jerusalem Board of Education District (JBED) in Israel. The five children with bilateral spastic CP-Gross Motor Function Classification System (GMFCS) level IV (Palisano et al., 1997; Cans et al., 2007) investigated in the study (including the pilot study) are all from this district. The participants were researched using a replication logic strategy of 4 cases studies. After the pilot study, Case Study 1 had two participants: A. Research and B. Control enabling the researcher to accommodate the needs of each case study child and the child's family. The need to simultaneously maintain the same conceptual framework and uniformity of treatments necessitated a firm framework. Treatment, interviews and evaluation were conducted in the Tamar school facility while other interviews and simple sitting treatments and evaluation were coordinated according to individual needs regarding location and communication. It is noted that all names of participants including identifying details such as names of schools, addresses etc. are fictitious in order to maintain the confidentiality of the participants.

#### **1.1.5 The Research Questions Addressed by the Research Design**

The research investigated the adaptation of children with CP using MMD applying multiple case studies strategy. Deduction from the responses to 'How' or 'Why' questions, favoured by case study experiments (Yin, 2003), enabled the researcher to establish whether the PIA intervention could enhance the lives of children with CP: quality of sitting, function, and the psychosocial domains of: GSW, PC, and PSE which may all affect the children's QOL. Other aspects of the RQ narrowed the problem studied by organising the research boundaries (Stake, 1995; Strauss and Corbin, 1998).

## **1.2 The Research Questions**

After reviewing previous knowledge on AT issues (Getz et al., 2007; Hadders-Algra et al., 2007; Rosenbaum, 2008; Fragala-Pincham et al., 2009) the researcher prepared the following RQ:

1. How and why did the posture and balance abilities of participants with CP change during free sitting on land, after the PIA intervention?
2. How and why did the Hand-Head Coordination (HHC) used in functional ADL abilities differ for participants with CP during free sitting on land, after intervention?
3. How and why did the perceived competence of participants with CP vary as a result of the intervention?
4. How and why was the QOL of participants with CP altered as a result of the intervention, and at follow-up one year after intervention?

## **1.3 Chapter Summary**

This chapter described the motivation for the research and its purpose. It explained the underlying adaptation paradigm for the research and the assumption that improved motor function adaptation might engender improvement and other adaptations in psychosocial domains, thus improving the research participants' QOL. It explained how a special PIA with a unique TTC was tested to discover whether it could decrease maladaptation of children with CP. The next chapter surveys the theoretical and research literature that examines relevant issues such as: CP, adaptation, environment, gravity, improved PIA principles, psychosocial aspects and QOL, shifting the thesis from the factual to the conceptual level.

## CHAPTER TWO: THEORETICAL PERSPECTIVES

### *Precis*

This chapter describes and explains the theories and research that underpin the present study. It relates to the main issues with which the research deals, namely: CP, the Environment, Water Therapy, Unloading and Loading Human Weight, PIA rehabilitation, and the enhancement of human psycho-social domains in QOL.

Each issue is explained through a detailed survey of the existing research and theoretical literature, enabling the researcher to identify gaps in existing knowledge and to construct the conceptual framework of the thesis, which is presented at the end of the chapter.

### **2.1 Definition of Cerebral Palsy (CP)**

This sub-chapter focuses on the definition and classification of CP. It describes the problematical issues associated with the definition of the CP condition. It concludes with the definition that was found most appropriate to represent the condition in present study.

Schenker (1994a), Pellegrino and Dormans (1998), Curdova, Vermeer and Válková (2001), Rosenbaum et al. (2008) and Shevell, Majnemer, Poulin and Law (2008) all suggest that ever since the CP concept appeared it has led to descriptions of diverse phenomena, confusion, controversy and attempts to establish objectivity because of the large amount of definitions, diagnosis and classifications it has been given. This indicates the problematic nature of the term and of the CP condition itself.

Peto, uses an educational approach to CE (Leon, 1987; Schenker, 1994), applying Darwinian concepts regarding biological adaptation to define motor disability (Leon, 1987; Hari and Akos, 1988). He describes the motor disability of CP as a group of maladaptation problems in the dysfunctional personality of the person with CP (Hari and Akos, 1988), '*We do not change the environment, but adapt the child's constitution*' (Maguire and Sutton, 2005, p.42).

Bax (1964 updated by Rosenbaum et al., 2007a, p.9) provided what has become a classic definition for the disorder and provides the underlying roots for the present study. This definition relates to rehabilitation relying on a cause-and-effect relationship, and proposing a clinical treatment strategy for CP phenomena.

*Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behaviour, by epilepsy, and by secondary musculoskeletal problems (p.9).*

This definition was chosen for the research, following a conversation that the researcher held on 10<sup>th</sup> December, 2007 with Professor Peter Rosenbaum, MD Paediatrics, McMaster University concerning a suitable definition for the research purpose-aim-paradigm and in consideration of three ideas regarding CP, described in the definition which instructed the researcher's conceptual paradigm:

- A. The concept of MP relates to and emphasises the system of motor impairment (Shevell et al., 2008; Hutzler, 2009) affecting all people with CP. The MP of children with CP is influenced by environmental gravity conditions. The main aim of the research intervention was to reduce this influence (Cole and Becker, 2004), using unloading (Becker and Garrett, 2004; Fragala-Pinkham et al., 2009) in order to facilitate the children's MP. The above chosen definition suggests the need for treatment of MP to ameliorate '*disorders ... causing activity limitation*' (p.9). Therefore the definition was appropriate for the research intervention view.
- B. '*Non-progressive disturbances*' (lesions) described by the definition are the end result of negative neurological processes and the cause for the CP primary impairment condition. The research intervention was directed specifically to ameliorate this primary impairment, that so detrimentally affects the CP condition and consequently to ameliorate secondary CP impairment (Christiansen and Lange, 2008; Liptak, 2008).

The research's rehabilitation paradigms for CP are based on and developed from the views of Hari and Akos (1988), Darwinian biological adaptation and MP as described by Bax (1964 supported by Rosenbaum et al., 2007a), which reinforce the decision to adopt the above definition of CP. The clinical approaches selected for the mixed intervention of the research were chosen in light of this definition e.g. NDT (Bobath, 1984; Howle, 2004), CE (Hari and Akos, 1988; Maguire and Sutton, 2005) and AT/PIA (Harrison et al., 1992; Miyoshi et al., 2004) in order to alleviate both primary and secondary problems created by CP.

## **2.2 The Main Problematic Issues Associated with CP**

This sub-chapter focuses on the issue of the maladaptation of people with CP in the areas of: Postural control, Central Nerve System (CNS), intellectual ability and human immersion in AT. Two major impairments and disabilities were considered in the context of the present study: Child's inability to develop postural control, and inability to adapt to the environment or opportunities afforded by it, so that restricted daily life functioning activities and participation ensue (Howle, 2004; Christiansen and Lange, 2008; Liptak, 2008).

### Postural Control Impairments

The child with CP begins to move from an abnormal posture, this forms a delayed, disturbed or maladapted cycle, and an inability to achieve normal motion in the environment. Bobath (1984, p.80) indicated that people with CP have a '*problem of postural control against gravity*', while Howle (2004) related to their '*inability to establish spatial and gravitational orientation*' (p.116) that affects their functioning. The present study aims to reduce gravity conditions (Farley and McMahon, 1992; Griffin et al., 1999; Cole and Becker, 2004; Miyoshi et al., 2004), to accommodate this postural control deficiency.

Further, CNS impairment affects the position of the head in relation to gravity, producing hypertonus, contractures, deformities, and interfering with head righting, (bringing the head to proper posture) and postural control, so that all limb movements are affected including flexion/extension synergies (Bobath 1971c; 1984; Huss, 1988; Pellegrio and Dormans, 1998; Van der Heide, Fock, Otten, Stremmelaar and Hadders-Algra 2005). Thus, orientation is more complex and the child has difficulty using motor functions and indeed, learning about the self and the world is impeded (Bobath, 1984; Scherzer and Tscharnuter, 1990).

### Intellectual Restriction-Maladaptation

The NDT approach (Bobath, 1984; Bobath and Bobath, 1984) suggests that the child's perception and vasomotor development is influenced by his physical development. The child with CP has restricted active movement capacity, manipulation skills, posture, coordination, and cognition leading to physical disability. Lack of independent movement and ability to 'experience' and interact with the environment-world, affects the infant's whole personality that will be restricted and deficient. He/she may become frustrated, develop behaviour problems, and have restricted perception and intellectual abilities. The child might be mentally challenged or have low intelligence (Abercrombie, 1960; 1968; Bobath, 1971a; 1971c; 1974; Rosenbloom, 1971; 1975; Scherzer and Tscharnuter, 1990; Levitt, 1995; Bax et al., 2005; Damiano, 2006; Rosenbaum et al., 2007).

The CE approach proposed by Brown (1997) and Hari (1997) sees the dysfunction of the child with CP as '*affecting the adaptive activity of the entire personality, [causing] disturbances of adjustment. We must regard motor disabilities as disturbances in adaptability affecting the whole personality*' (Hari and Akos, 1988, p.16).

The NDT approach (Bobath, 1971c; 1974) agrees that there is an influence on personality and suggests that: *'In Cerebral Palsy, therefore, the interaction of the physical handicap and the intellectual and emotional development of the child will lead to a disturbance of the growth of the total personality'* (Bobath, 1963a, p.3).

Both these approaches agree that the cause of CP and all ensuing disabilities are primary and secondary impairments of sensorimotor deprivation in the development of the adaptation of the child with CP to the environment (Bartlett and Palisano, 2002; Maguire and Sutton, 2005; Rosenbaum et al., 2007a).

### Critique of NDT and CE Approaches

Relating to NDT, the Bobaths admitted *'it is not a method'*...[it is] *'almost religious fervor exhibited by some therapists'* (Bleck, 1985, p.370). The NDT approach is based on several assumptions and clinical concepts some of which are not accepted in current practice (Howle, 2004). Recently, NDT has proved unable to support more normal movement patterns involved in gait cycle (Lennon, Ashburn and Baxter, 2006) thus, *'the multidisciplinary therapy-based approach [NDT] has signally failed to provide any scientific proof of its own efficacy over the past 20 years'* (Maguire and Nanton, 2005, p.65). Systems Theory (an understanding of human behavior based on dynamic systems) appears to be more efficacious to the understanding of motor learning than developmental approaches (Kurtz, 2002).

Stanton, (2002) criticised contemporary CE for being exclusive, treating children with higher intellectual and physical abilities, with a level of demand and intensity of treatment on a small child that differed from the original approach in Hungary. Treatment focused on one professional who treated the entire range of a child's development. It is difficult to judge the effectiveness of such programmes due to differences in the approaches of the different institutions.

### Aquatic Therapy

There is limited research and true scientific information on the effects of water treatment in AT (Koury, 1996; McIlveen and Robertson, 1998; Campion, 1998d; Kelly and Darrah, 2005; Fragala-Pinkham et al., 2009). This was highlighted by Cunningham (1997): *'The greatest weakness was the lack of understanding of the degree to which the human body adapts and changes its systems when immersed'* (p.308).



## 2.3 The Great Environment

The environment or extrinsic life conditions were thought by Darwin to be so strong as to weaken one's behaviour. According to Romanes (1895) this is: *'The direct action of external conditions, and variations which seem to us in our ignorance to arise spontaneously'* (p.8). This influence may be relevant with regard to infants with CNS pathology who even develop atypical relationships with the environment as they attempt to solve their adaptive functioning problems with their limited MP (Scherzer and Tscharnuter, 1990; Fetters, 1991; Howle, 2004; Liptak, 2008). The present research attempts to manipulate the environment to improve the adaptation of these children. Any pathology is influenced by contextual factors defined as:

*... factors that together constitute the complete context of an individual's life, and, in particular, the background against which health states are classified in ICF'-International Classification of Functioning* (WHO, 2007, p.229).

These environmental factors are divided into two types:

1. Extrinsic-environmental factors (defined in Chapter 1: Introduction) conduct a constant mutual interrelationship-influence on the intrinsic-personal system of organisms (Shevell et al., 2008). For humans, these intrinsic systems are composed of 'personal factors', defined by the WHO (2007) as *'contextual factors that relate to the individual, such as age, gender, social status, life experiences and so on'* (p.229), and *'their assessment is left to the user, if needed'* (p.18).

Pavlov used the term Black Box Model (BBM) (Hari and Akose, 1988, p.142; Croce and DePaepe, 1989; Schmidt, 1992) to refer to the internal processes of organism systems affected by the environment. This term was adopted and used in the present inquiry. The research-intervention model begins with environmental input entering into and influencing human systems -(BBM) and then returning to the environment as output - as mentioned also by IPT (Schmidt, 1991; 1992).

2. Another type of factor defined as: *'facilitators, are factors in a person's environment that, through their absence or presence improve functioning and reduce disability'* (WHO, 2007, p.229) e.g. the person's physical environment, assisting technology, services and policies.

### Closed/Open Environment

Backer, (2004) saw closed chain exercises as moving against a ground of fixed resistance while open chain exercises e.g. swimming-horizontal exercises enable the individual to perform any activity. Schmidt (1991; 1992), Gentile (2000) and VanSant (2003) drew a distinction between closed and open environments:

Closed environment conditions are stationary-unchanged so that movements are controlled by the features of environment, e.g. the shape of the room, location of furniture etc. Closed environments provide the optimal conditions for learning tasks because they reduce the need to adapt to a variety of variables. However this restricts the probability of effective transfer of acquired skills to more variable functioning situations. The height of a chair is a closed environment feature to which the participant aims to adapt.

Open environment conditions are conditions in which motions are influenced by changeable objects. They determine the participant's movements and changing conditions will influence successive attempts. Thus, an open environment is advantageous since it offers more adaptability for flexibility in motor performance as the client attempts to meet the environment's demands. An example is a busy city street or shopping in a mall.

The PIA used in this research applied unloading toward loading, which in contrast to the loading to unloading (Lambeck et al., 2004; Borggraefe et al., 2008), started with unloading in a 'closed environment' which enabled the child to adapt then decreasing immersion to improve adaptation to the 'open environment' till it also became a 'closed environment' for the child. This process was repeated time and again gradually increasing the area of 'open environment' to become a predictable 'closed environment' for children with CP.

The Ecological Approach (EA) proposed by Bronfenbrenner (1979) broadens child development theory by focusing on the family and parental involvement in a sociological environment context. NDT and CE emphasise the importance of the home-parents-family relationship (Bobath and Bobath 1984; Schenker, 1994b; 1997), and advocate the concept of Family Centred Services (FCS) focused on the child with CP (Dunst, Trivette and Deal, 1988; Rosenbaum, King, Law, King and Evans, 1998; King, Teplicky, King and Rosenbaum, 2004), in the context of: family, school, community, outdoor activities and culture with life-long participation within an EA framework (Van der Meer and Van der Weel, 1999; Meyers, 2002; King et al., 2002; 2004; Shevell et al., 2008).

This collaboration with the social environment involves different systems. One such system is the Parenting Style which has a dominant influence in the family context on the psychosocial development of the child (Xia and Qian, 2001; Wood, McLeod, Sigman, Hwang and Chu, 2003). There are four Parenting Styles:

- Authoritarian: restricts and controls the child feelings and thinking (Schaefer, 1965; Barber, 1996).
- Autonomous: gives the child more freedom and independent activity (Wood et al., 2003).
- Rejecting: exhibits hostility, coldness, indifference and little pleasure being with the child.
- Supportive: exhibits acceptance showing warm, active listening, welcoming and actively emotionally involved in the child's life (Aran, Shalev, Biran and Gross-Tsur, 2007).

In addition EA emphasises the need for congruence between the extrinsic task and the intrinsic organism-CP child (Palisano, Snider, and Orlin, 2004; Ahl et al., 2005).

This concept is also found in other theories such as MCLT, Motor Development Theory, BBM in CE (Hari and Akos, 1988; Schmidt, 1991; VanSant, 2003), IPT (Van der Meer and Van der Weel, 1999; Sugden, 2007), DST (Thelen, 1995; Thelen and Spencer, 1998), NDT (Howle, 2004), and by the WHO (2007).

The strategy of shaping the environment through teamwork or as in the present study through PIA complies with the principle of the Child and FCS (Rosenbaum et al., 1998 relates to the focus of EA on Child and Family during the rehabilitation process).

#### Sensations from the Environment

The concept of the hierarchical structure of the CNS sensory input system, based on 'hard-wired' motor function organisation formed the basis for the concept of motor feedback in Sherrington's Reflex Theory. The critique of this model is based on the assumption that human movement stimulates the CNS due to sensory input for example: when a body accelerates suddenly, in a car, a flexion compensation reaction of neck and trunk takes place thus protecting the body from falling backward (Morris, 2004). Moreover, in animal research when a sensory ending neuron is destroyed, the animal still shows purposeful and coordinated movement with anticipation and control of feed forward (Taub, 1976; Evarts, Shinoda and Wise, 1884). Thus, reflex theory cannot sufficiently explain skilled movement production (Morris, 2004).

MCLT (Schmidt, 1991; 1992) and Howle (2004) described two sensory systems that work together in well coordinated movement. The first, the 'Feed-Forward' active mechanism employs spontaneous adaptive synergies that act according to the demands of functional problems when the child anticipates as well as initiates the movement according to the demands of the task, based on a proactive approach to the motor action. The action is influenced by learning from experience, environmental conditions, and the task (Howle, 2004; Ben-Phazi, 2009; Shalev, 2009).

Second, is 'Feedback' that aims to correct any difference between the intended movement and the actual movement. It triggers a reactive system that either adapts or regulates movement to form new movement combinations as an optimal response according to context and nature of motor behaviour (Bly, 1996; Gordon, 2000 in Howle, 2004).

EA also includes certain principles of Affordance Theory (Gibson, 1982; 1988; Gibson and Pick, 2003). This theory perceives the world in terms of object shapes with spatial relationships between objects, triggering and leading to possibilities for action according to the individual's perception of the environment. The theory sees social and physical activity, perception and action, as reactions in relation to the environment. These ideas also accord with the cognitive motor approach, incorporating MCLT and Motor Development Theory; anticipation of postural adjustments regulated by feedback, and feed-forward and concepts from the BBM and DST relating to the interaction between extrinsic and intrinsic systems (Thelen and Ulrich, 1991; Jensen, Schneider, Ulrich, and Thelen, 1994).

However, people with CNS pathology show 'maladaptive' MP and cannot meet the demands of tasks due to their lack of successful 'experience' in performing the task (Howle, 2004). Therefore, the PIA used in this research aims to improve the feed-forward strategy, but at the same time has to establish good control of feedback during the new learning produced by the intervention process (Connolly and Montgomery, 2003).

To summarise, an individual uses feedback to regulate and 'adapt' movement to the constraints of the environment. Any error detection, and/or error correction plays a dominant role in adapting locomotion in functional contexts while, feed-forward and feedback therefore contribute to well-coordinated MP (Bax, 1964; Howel, 2004).

### Gravity Environment

The somatic element of the child with CP in its natural environment is subject to the principle of full gravity loading (Harrison et al., 1992; Wilder and Brennan, 2004; Lennon et al.; Ashburn and Baxter, 2006). *'We move ... constantly against the pull of gravity ... [and] each movement changes the relationship of the point of gravity of our body with the floor'* (Bobath, 1971c, p.2).

The present study focuses on the issue of reduced gravity conditions using buoyancy to manipulate gravity conditions by RCPWB, enhancing motor adaptation through the developed PIA with an improved TTC. This contrasts with all types of treatments which operate on children with CP in an environment of full-natural gravity conditions. This effects *'the limb may also feel resistant to movement, which indicates that it does not have the ability to combat gravity appropriately for function'* (Preston, 2001, p.376).

#### **2.3.1 Gravity: The Limitations and Beneficial Effects imposed on Earth's Environment**

A central consideration in the choice of the present research topic was the principle of gravity. Most scholars investigating MP of humans, mention gravity as an important variable, however until now no attempt has been made to control conditions of gravity by decreasing immersion, or altering loads of gravity.

### Bernstein Environment

The revolutionary approach of Bernstein (1967) contributes to the present study in three ways:

1. The claim that movement is based on coordination involving many body parts and leading to a united process outcome (Turvey, 1990).
2. His basic hypothesis supports the concepts of CE and NDT, the chosen approaches guiding treatment in this study. CE also adopts Bernstein's view that *'motor functions are of great biological significance'* (Bernstein, 1967 in Hari and Akos, 1988, p.15).
3. Third, both Bobath and Bernstein clearly state that *'... as your body parts move, they generate inertial and centripetal forces and are subject to gravity'* (Thelen, 1995, p.80).

This new revolutionary perspective also perceived gravity as a significant variable in the execution of MP (Rosenbaum et al., 2007a), as part of the individual's relationship with the environment which includes: type of task required, body position, neuromuscular system, body mass, viscosity, inertia, and effect of gravity field on the outcome (Thelen, 1995; Thelen and Spencer, 1998; Smith and Thelen, 2003).

The importance of different angles of posture condition in order to orient the body to gravity, shows the effect of gravity on the body's motor system but also its benefits since gravity shapes the outcome of motion, assisting joint flexion and extrinsic systems.

The imperative that indicates that gravity affects inertial and centripetal forces also indicates that it is possible to engender a behaviour change by using anatomical and energetic constraints in addition to the ultimate neural commands (Jensen et al., 1994), exhibited in the Hierarchical Reflex Model (Morris, 1997; 2004).

According to this model higher cerebral cortex centres control lower brainstem and spinal cord centres. Critique regarding this model stems from the fact that experimental studies that produced lesions in midbrains of cats, (disconnecting higher and lower CNS structures), failed to prohibit coordinated purposeful movement (Shik and Orlovsky, 1976). Additionally, reflexive movements may overrule normal human voluntary purposeful functional movements. E.g. if one steps on a nail the leg reflexively withdraws while the other leg supporting the body extends. These examples suggest that the hierarchical model demonstrates the inaccuracy of human motor control (Morris, 2004).

The new imperative proposed by Bernstein (1967 in Howle, 2004; Sugden, 2007) indicates that gravity (type of extrinsic-environment) forms 'degrees of freedom'. This concept theorises that gravity has important consequences for the organism's behaviour in the environment in contrast to the previously accepted concept that the neural-CNS is the exclusive controller of such behaviour. Bernstein's (1967) 'degrees of freedom' concept opens a new field of knowledge for investigation.

#### Gravity Affects Movement and Posture

Bobath (1984) states that MP *'are the common heritage of man'* (p.6), while *'man [has an] evolving ability to resist gravity'* thus *'every movement and every postural change will produce a shift of the relationship of the body's point of gravity with respect to the supporting ground'* (p.4). MP is the demon of the CP phenomena as Bax, Goldstein, Rosenbaum, Leviton and Paneth (2005, p.573) state that MP *'is the core feature of CP'* and that *'the motor impairments [are]...the hallmark of CP'* (p.575).

Both elements of this concept, 'Movement' and 'Posture' are in reality formed *'against gravity'*; (Howle, 2004; Zaino and McCoy, 2008).

NDT sees this situation as follows: *'Man has ... defences against the forces of gravity'* (Bobath, 1984, p.9) therefore *'in treatment ... motor development should be taught in terms of "development of coordination" of postural control against gravity'* (Bobath, 1972, p.29). CE explains that when people with CP lift *'... their arm up, they do not receive the perceptual information from the joint*

*receptors which tell them that they are moving outside of their gravity point'* (Maguire and Nanton, 2005, p.26).

In sitting contexts, the child with CP is unable to orient its MP against the pull of gravity. Several difficulties disable the child with CP from accomplishing purposeful movements: including the difficulty of maintaining erect position, at rest and while passive in relation to a sitting base of support. Nevertheless, problems involved in achieving dynamic postural adaptation, or adjustment to a specific task, to be able to support surface contact, produce a proximal reaction, and achieve head with trunk and spinal alignment and stability (Reid, 1995; 1997; Tscharnuter, 2002; Hadders-Algra et al., 2007).

The definition of CP that the researcher adopted links 'normal posture' abilities with the effects of 'gravity'. The term 'normal posture' is defined as the

*... attainment of postural alignment of head and trunk against gravitational forces above the supporting surface and adjustment of body parts in relation to each other* (Myhr and von Wendt, 1991 in Myhr, Wendt and Sandberg 1993, p.25).

Moreover the researcher noted that:

*The effects of gravity are so fundamental to motor control and motor development that it is difficult even to think of this in a separate context. It is the one consistency among highly interactive, interdependent brain, body, and environment systems. Throughout life, individuals (with or without neuropathology) must adjust and adapt to the invariant effects of gravity. The job of the newborn (or CP) is to organise movement against the forces of gravity* (Howle, 2004, p.40).

The desire to reduce the conditions of gravity formed a firm boundary for the study.

In CP, maladaptive pathology means that there is a lack of experience in successful response to the demands of tasks and the environment (Howle, 2004; Ozer et al., 2007). The infant does not perform motor activities against gravity, for example sitting up. The child's development includes delayed head righting and there is a delay in abilities to initiate movements and change postures, affecting normal movement (Bobath and Finnie, 1958a; Bobath, 1963b; 1967b; 1971c; 1974; 1984; Scherzer and Tscharnuter, 1990; United Cerebral Palsy, 1995; Reid, 1996; Preston, 2001; Howle, 2004). There is therefore reduced ability to develop postural control and appropriate functioning (Scherzer and Tscharnuter, 1990; Howle, 2004; Van der Heide et al., 2005; Hadders-Algra et al., 2007; Zaino and McCoy, 2008). The outcome is maladaptation to the environment (Scherzer and Tscharnuter, 1990; Brogren et al., 2001; Howle, 2004; Van der Heide et al., 2005; Bax et al., 2005).

Postural control develops according to milestones, against the force of gravity, enabling control of the body in space, gaining stability with orientation that develops from the

integration of multiple systems which are organised around a task and affected by the gravity conditions of the environment (Shumway-Cook and Woollacott, 2001 in Howle, 2004) on task-specific relationships (Howle, 2004).

### Development in the Environment

The work of Gesell (1941; 1946), Griffiths (1954), and Bayley (1969) and other researchers indicates the importance of the Motor Development sequence '*Piaget also saw the child as a "lone scientist", who develops from one stage to the other*' (Tatlow, 1997, p.36). The pattern of motor development of a child with CP does not match the development of a normal child.

It is suggested that there is a broad range of 'Motor Milestones' according to chronological age (Bobath, 1967; Rosenbaum et al., 2008). CE accepts this theory (Hari and Akos, 1988).

Howle (2004) suggests that the alignment of the base of support (parts of body in contact with ground) e.g during sitting, with the centre-pull of gravity enhances activation and elongation of muscles. Thus, if the therapist employs RCPWB, this will affect these two variables and may improve sitting.

### Aquatic Therapy support for Development

The developmental theory expressed by NDT and CE also appears in MCLT, IPT, EA and DST. The developmental viewpoint adopted by AT approaches was one of the reasons for the choice of these approaches for this study. Thus HA was chosen since it is based on the concept of mental adjustment/adaptation to the AT environment according to age and needs (Lambeck et al., 2004). Other chosen AT approaches: WA, BRRM, TTTA and PAT all use facilitation and adaptation principles gradually increasing task difficulty or maneuvers using the principles of engagement-support and disengagement-support, withdrawal (Cunningham, 1997) in developmental stages according to context, age and abilities.



## 2.4 Unloading and Loading Human Weight

The theory of unloading and loading of human weight can be applied in four possible environments in a gradually descending sequence:



and an additional environment can be added - the combination of the last two (LAND and WATER) which constitutes the new environment of the PIA used in the present study. The present research attempted to discover how the physical laws governing these environments enhanced or constrained motor control ability (Howle, 2004).

### Space Knowledge

It is not practical to use the environment of SPACE in the present study, although there is a new approach developed from space knowledge called Adeli Suit Treatment (Liptak, 2005: Bar-Haim et al., 2006).

### Land Environment

There are two ways to achieve unloading or to use microgravity simulation on land. The first uses parabolic flight, the acceleration of an airplane against gravity, which is outside the present study framework. The second is to use neutral buoyancy test facilities, in other words, the aquatic environment (Toscano et al., 2004).

Treatment theories of loading and unloading refer to the normal effect of gravity on human weight in a land environment. The theory of loading humans with extra weight to develop strength uses a principle that is opposite to the principle of PIA-unloading toward loading and was therefore considered irrelevant for the present study.

The study followed and developed the Rehabilitation Principles from land and AT-water approaches and combined land and water environments and applied them in the PIA as described below. The chosen land approaches are theoretically and practically linked to the chosen AT approaches and principles used.

The developed PIA follows the concepts of CP and adaptation used in Western NDT and Eastern CE approaches, and their associated theories and consequently uses AT-water buoyancy for unloading toward land loading of gravity-controlled environments aiming to improve motor function adaptation in order to rehabilitate children with CP.

Twelve PIA Rehabilitation Principles are now explained:

#### **2.4.1 Adaptation**

*'One of the great changes which has been wrought in biological science by the Darwinian theory of natural selection, consists in its having furnished an intelligible explanation of the phenomena of adaptation'* (Romanes, 1895, p.159).

Darwin stated: *'I soon perceived that selection was the keystone to man's success'* (Barlow, 1958, p.119). Yet, Romanes (1895, p.163) explained: *'It is by no means the same proposition to affirm that the theory of natural selection is a theory of the origin of species, and that it is a theory of the origin of adaptations'*. This reaffirmed the research's adaptation paradigm based on the application of selection and adaptation processes of species, that forms the root for the conceptual foundation of the present research.

#### **Neuronal Group Selection Theory**

Neuronal group selection theory integrates knowledge regarding brain damage, activity-task and environment to explain deficiencies in appropriate functional activity and explains how trial and error strategy might affect a person's actions, by allowing selective activation of neuronal groups to be strengthened toward adaptive functioning. The theory based on the organism's 'experience' of moving which influences the individual's selection of primary neuronal repertoires according to their adaptive value (Sporns and Edelman, 1993; Ben-Phazi, 2009; Shalev, 2009).

#### **System Theory**

System Theory envisages the use of various body systems in order to reduce the complexity and exclusive control of the CNS over human MP. Bernstein (1967) applied this idea of dynamic systems to human motor behaviour. He saw the complexity of the organism as a multi-dimensional interactive system in which the behaviour of the total system is organised without particular preference for one subsystem over another subsystem.

EA also explains that behaviour change is engendered by multiple strategies and factors used for a variety of intervention needs and domains. EA and DST differs from PIA since neither of them acknowledges the specific importance of a one-variable stimulated behavioral system change. Instead, they assert that all subsystems have equal potential priority/ propensity to engender performance of change in the behavioural system (EA-King et al., 2002; Elder et al., 2007; DST-Thelen, 1995; Thelen and Spencer, 1998; Sugden, 2007; WHO, 2007). In contrast, the PIA developed in this research acknowledges the

specific importance of one variable that stimulates system change: the environmental adaptation-RCPWB variable enabling the child to improve motor functioning adaptation.

System Theory sees independent parts e.g. joints and muscles as a single functional unit called a '*coordinative structure*' (Zernicke and Schneider, 1993) that is dictated by the functional task (Howle 2004), and demonstrates flexibility as a process of learning takes place (Bernstein 1967).

System Theory was developed in the present research to relate to the interaction between the body system (e.g. muscular power, body mass, biomechanical properties) and requirements of the task (e.g. predictability, meaningfulness), and laws of the environment (e.g. support surface, friction and gravity) (Carson and Riek, 2001; Howle, 2004). This last mentioned element the extrinsic 'environment' is influenced by 'gravity' which forms the field of 'degrees of freedom'. Indeed, the environment constitutes an infinite 'space' for variability and therefore degrees of freedom. The present research intervention was able to manipulate the influence of gravity in the child's extrinsic environment thus enabling an alteration to be created in the child's intrinsic system so that it adapted better to its natural environment on land.

### **Dynamic System Theory**

DST does not accept that the CNS has ultimate control over motor control. It argues that there is an interaction of many types of systems so that when those systems predict instability, the individual systems are forced to become flexible and selectively choose more adaptive activity based on accumulated experience of existence in the environment and learning how to adapt to it (Thelen, 1995; Morris, 2004). DST stipulates that it is necessary to identify which subsystems are influential in order to engender total system change (Deitz Curry, 1998).

Critique of DST asserts that the assertion that movements occur as a result of interactions between the involved systems, provides poor explanation for motor control (Morris, 2004). The interaction of such systems are not well defined and the connections of those systems to neuroanatomic structures are not well explained (Horak, 1990; Gordon, 2000; Shumway-Cook and Woollacott, 2001).

Social Cognitive Theory (SCT) relates to the concept of Perceived Self-Efficacy (PSE), claiming that the assertion of personal rights and self-determination positively impact on human adaptation. Thus, it involved those systems parts including: commitments, self-management, aspirations, cognition, and motivation, but what is important for the present research is that the SCT structural model (Bandura, Caprara, Barbaranelli, Gerbino and

Pastorelli, 2003), demonstrates how perceived effective self-regulation operates in concert with action.

According to this model, PSE governs various diverse processes of adaptation, through the spheres of self-regulatory efficacy during pro-social and/or anti-social functioning. These processes operate in dynamic multi-causality systems, each of which can cause change, so that PSE actually regulates socio-emotional functioning.

The perspective on adaptation shared by all the above-mentioned theories (ST, DST, EA, SCT and PIA) relates to the involvement of a number of common dynamic systems but what is more important is that they all indicate an identical end product: behavioural change. Stamm et al. (2008) identified another paradigm of adaptation in the context of life stories of people with Rheumatoid Arthritis, which focused on mastering challenging activities, a process defined by Stamm *'as having the upper hand in ... display of great skill or technique, or a skill or knowledge that makes one master of a subject'* (p.662).

#### Importance of the Environment

Bernstein (1967); King (1978); Kielhofner (2004), Rosenbaum et al. (2007), Sugden, (2007), and Zaino and McCoy (2008) all suggest *'the roles of environmental'* influences (Rosenbaum, 2003, p.90, Supplement. See also SCT, Bandura 1986; 1992; 2002).

Bandura uses the term 'natural selection' (Darwin, 1958), to explain personal coping capabilities that enable humans to handle selected activities in a varied environment, thus enabling a person to develop and enhance competencies (Bandura, Jeffery and Gajdos, 1975; Bandura, 1982; Bandura 1989; Ozer and Bandura, 1990).

The Family Centred Service proposed by EA uses Affordances Theory (Gibson, 1979), which theorises that there are various environmental possibilities and situations which the organism is able to detect in order to increase functional mobility performance in the environment. Thus, the child with CP must develop the ability to anticipate and predict the environment (Van der Meer and Van der Weel, 1999; Tieman, Palisano, Gracely and Rosenbaum, 2004). These capabilities offer the child a variety of possible reactions in order to adapt to the environment through an inductive process.

EA asserts that children with any health condition have the potential for dynamic change, tailored to suit all individual behaviours (Luria, 1973; Elder et al., 2007). NDT recognises the environment as a 'tool' and the persons in it as creating powerful incentives for movement, while it sees the human motor system as exhibiting flexibility and adaptability to produce changes necessary to perform the required environmental tasks (Howle, 2004). Against this theoretical background that indicates improvement of adaptation through an

appropriate environment, the present researcher was inspired to develop a new treatment environment, based on the proposition that people with CP will adapt better during sitting in water. Both CE and NDT land and AT approaches which were selected (HA, BRRM, WA, TTTA and PAT) emphasise the importance of adaptation (Cunningham, 1997; Lambeck et al. 2004). The development of a new tool, the TTC, employed this sitting strategy to enhance adaptation thus facilitating skills acquisition. This tool was used a mechanical solution, for RCPWB, and thus created change in the environment (lifting TTC to reduce immersion-buoyancy and 'increasing gravity', using a telescope square sleeve with pin hole every 30mm).

### **Toward PIA Adaptation**

CE is based on the biological adaptation paradigm which *'is highly useful in biology in the sense of Darwinian adaptation'* (Hari and Akos, 1988, p.138; Shanahan, 2004). The NDT view is that *'for efficient and controlled transitions, postural adaptations must occur throughout the body'* (Scherzer and Tscharnuter, 1990, p.298; Van der Heide et al., 2005).

A more recent view of DST suggests that *'the roles of exploration and selection [are effective] in finding solutions to new tasks. This means that infants must assemble adaptive patterns from modifying their current movement dynamics'* (Thelen 1995, p.85). This last view is parallel to and expands the CE view, which is based both on biological and selective adaptation.

According to CE, adaptation can be taught to improve regular ADL using the principle of Pavlov's constructing reflex conditioning, through concentration and repetition (Cotton, 1970; Schenker 1994) in goal-oriented task series (Cotton, 1965; 1970; 1974; Koury, 1996; Howle, 2004; Maguire and Sutton, 2005), NDT and PNF also suggest that to acquire a skill, motor learning and activities, repetition, training and experience are needed (Deitz-Curry, 1998; Pope-Davis, 2001; Howle, 2004; Ben-Phazi, 2009; Shalev, 2009).

The present research uses all the above-mentioned principles transferring them to the AT environment where buoyancy and gravity, act on the child with CP in water. These two forces can be RCPWB by lifting the TTC, to facilitate adaptation.

### **Aquatic Adaptation**

Aquatic adaptation is used by many intervention approaches in water. This sub-chapter considers the main approaches, whose principles were applied to the present research.

### Halliwick Approach (HA)

In addition to teaching water safety, fun, swimming, physical balance and encouraging water activity for disabled people, one of the aims of HA is mental adjustment, i.e. adaptation (Martin, 1981; Association of Swimming Therapy (AST), 1992; Campion, 1998e,f; Vargas, 2004). Two principles are used:

1. Engagement: support for the patient by the therapist.
2. Disengagement: withdrawing the support from the patient (Cunningham, 1997).

HA aims to produce complete independence (Lambeck et al., 2004; Vargas, 2004; Sova, 2006), this corresponds with the aims of NDT and CE for independent sitting (Cotton, 1965; Cotton and Parnwell, 1967; Bobath 1984). Independence in water is achieved using the following principle: '*Mental adjustment and disengagement is mental adaptation*' (Lambeck et al., 2004, p.76). BRRM uses the same above principle in activity from proximal to distal support while increasing strength and ROM. Both approaches facilitate movement patterns from lesser to greater difficulty, through partial, minimal support until independent physical control is adopted (AST, 1992; Cunningham, 1997; Garrett, 1997; Morris, 1997; 2004; Vargas, 2004).

### Task Type Training Approach (TTTA)

TTTA is a task oriented approach using an active problem-solving strategy that encourages participation and independence with reduced assistance (Morris 1997; 2004). The disengagement process uses a specificity training principle (Schmidt and Wrisberg, 2004; Borggraefe et al., 2008), a specificity functional tasks strategy that helps the individual adapt the performance of skills to various environments using different conditions: grass, stairs, different lighting conditions and obstacles including aquatics and different positions (Morris, 2004; Capelovitch, 2005).

The use of Task Oriented Approach is criticised in AT since participants typically lack abilities to achieve active problem solving skills due to mental or physical disability and it is difficult to maintain the progression principle with participants' participation (Morris, 2004).

### **Pediatric Aquatics Therapy (PAT)**

According to PAT, the therapist should adapt the activities and skills in the aquatic environment to a progression of skills acquisition (Petersen, 2004; Vargas, 2004).

HA, BRRM, TTTA, PAT and PIA all use the above-mentioned principles during sitting, flexion and extension, in shoulder depth of water as a unified task. PIA treatment applied in present study used three strategies:

1. Slow progressive withdrawal of support, from centre - the head and trunk outwards to hands and legs.
2. Adaptation according to the '*depth of the water*', introducing an unloading (Lambeck et al., 2004, p.78; McAvoy, 2006), toward loading strategy (Harrison et al., 1992; Miyoshi et al., 2004). The opposite strategy (loading-to-unloading) was not viable in present study because it does not provide buoyancy support from the start of treatment, rather at the end of treatment (Lambeck et al., 2004, p.75; Borggraefe et al., 2008).
3. ADL skills were incorporated e.g. the participant reaches for a tooth-brush or spoon and brings it to mouth (Clarke and Evans, 1973; Morris, 1997; 2004).

AT approaches shaped the PIA to comply with NDT, CE, PNF, Neurophysiological Approach (a sensorimotor technique that facilitates, and/or inhibits involuntary and voluntary muscle action), and Movement Therapy (that uses synergetic reflexes as a stage in recovery toward further recovery), (Huss, 1988; Levitt, 1995; Pope-Davis, 2001). These land approaches influenced the chosen AT approaches.

Bobath and Bobath, (1984), Law, Darrah, and Pollack, (1998a), Morris (2004) and Maguire and Sutton, (2005) all criticised the above-mentioned Neuro-Senso-Motor Facilitation and Inhibitions Approaches since changing primitive reflex movement patterns does not develop normal functional movement and cannot be carried-over toward normal functional ADL activity. These Neuro-Senso-Motor approaches also fail to consider relevant musculoskeletal and environmental factors which affect motion, thus most of the treatments are based on a passive strategy (Morris 2004).

Since sensory adaptation, described in many theories (e.g. NDT and CE) is an ability that is usually neglected by treatment for people with CP, this was therefore chosen as the paradigm of the present study. The need to relate to sensory adaptation underpinned the researcher's selection of land and AT approaches, treatment principles, and the use of the improved TTC to develop the PIA and influence sitting adaptation of the child with CP in AT. AT environment benefits for populations with CP conditions, are well documented in the literature e.g. from Peganoff, (1984) to Fragala-Pinkham et al. (2009) at present.

## 2.4.2 Movement and Posture

A definition of MP attributed to Sherrington (1913 in Bobath, 1984) argued that sensation is the basic experience that triggers movement production.

Twitchell adopted Sherrington's argument and added: *'The learning of movements is entirely dependent upon sensory experience, upon sensory input which not only initiates but also guides motor output'* (Bobath, 1967, p.373). According to Hari and Akos (1988), CE applies this strategy as a *'black box function'* (p.139), while Motor Learning Theory calls this process IPT (Schmidt, 1991; 1992).

The CE approach sees movement in the context of organism adaptation. Bernstein (1967), argued that motor function in movement is of *'great biological significance'* (Hari and Akos, 1988, p.15). The organism is not isolated, unattached, but acts in a real environment influenced by biological and social conditions.

DST conceptualises that *'movement arises from a confluence of processes and constraints in the organism and environment. A change in posture is a change in the relationship between the mass of the body and the gravitational field'* (Thelen, 1995, p.81). Following brain damage, voluntary movement, input sensation, posture and functional skills might be reduced during output.

BRRM, Movement Therapy and PNF all use diagonals-rotation pattern between shoulders following to the hip, pelvis and vice versa with CP population (Bobath 1967b; 1984; Kott, 1967; Tscharnuter, 1993; Pope-Davis, 2001; Mitchell and Ogden, 2002). Diagonals are patterns of movement, providing the most effective *'direction in which muscles can pull'* (Knott, 1967, p.4).

One of the PNF principles suggests that normal motor behaviour in movement involves the intentional use of extremity of both flexion and extension (Pope-Davis 2001). Therefore, PIA treatment practices free sitting using forward diagonals flexion and extending the trunk backwards to achieve 'sitting balance', as defined by Reid (1997). This strategy was applied in the present study using Goniometric and Sitting Assessment for Children with Neuromotor Dysfunction (SACND) evaluation tools.

In the present research, these concepts underpinned the development of the innovative TTC chair which created new treatment environments to facilitate MP and thus increase adaptation.



### Movement and Posture in an Aquatics Environment

An aquatic environment with the physical properties of water e.g. Archimedes principle, meta-centre and shape and density (Appendix 1: Aquatic Principle), provides significant rehabilitation benefits (Koury, 1996; Hutzler, Chacham, Bergman and Reches, 1998; Hutzler et al., 1998a; Lepore et al., 1998; Becker, 2004; Morris, 2004; Becker and Garrett, 2004). Some authors (Campion, 1985; Davis and Harrison, 1988) assert that AT produces sensory disturbances such as reduction of joint receptors' stimuli, and proprioceptive input, which make movement more difficult in water. Morris (1997) argued in opposition that AT offers opportunities for activities which are impossible for some people on land.

### Water Movement and ADL

BRRM, HA, TTTA and PAT all offer Task Oriented Training using ADL activities in AT to improve land dressing, personal hygiene and postural stability developing balance, gross motor skills and strength. These strategies enhance functioning, and improve problem-solving enabling a person to overcome the impairments in the AT environment (AST, 1992; Koury, 1996; Pope-Davis, 2001 Morris, 1997; 2004; Petersen, 2004).

### **2.4.3 Head and Body Righting**

Jackson was the first to claim that reflex reactions will re-appear after assault to the CNS (Brunnstrom, 1970). Supported by the Neurophysiological Approach (Rood, 1956; Huss, 1988). Bobath (1984) and Bobath and Bobath (1984) suggested the concept of the postural reflex mechanism mentioned in Movement Therapy (Brunnstrom, 1961; 1970; Pedretti, 2001), indicating that there are specific reflexes which control *'head and neck movement, significantly [affecting] arm and leg movement'* (Pope-Davis, 2001, p.608) also supported by DST (Thelen and Spencer, 1998); According to NDT, righting is necessary because *'weight shift is often initiated from the head'* (Scherzer and Tscharnuter, 1990, p.253), therefore, the head is the starting point for correct sitting posture and guide body movement (Campion, 1998e) CE (Cotton and Parnwell, 1967). *'Where the eyes go, the head follows and so [does] the body'* (Jegasothy, 1998, p.192). This eyes-head-body rule suggests that vision influences head position and enhances the direction and response of body movement e.g. better reaching (Thelen and Spencer, 1998; Pope-Davis, 2001).

### Righting and Reflex in an Aquatics Environment

HA and PAT emphasises the facilitation of head movements thus, head greatly influences the position of the body in the water. The head is used to change direction and adjust posture in water, it also alters shape and meta-centric effects to counterbalance the rotational effects in water, and similarly it continues the effects of Cephalous to Tail-Caudal

Principle intervention involving the shoulders, arms, spine and lower extremities (Cunningham, 1997; Campion, 1998f; Lambeck et al., 2004; Morris, 2004; Petersen, 2004; Vargas, 2004).

The TTC employed in PIA in water enabled the child's head to follow the researcher's finger signing, flexing their trunk forward till their nose touched the researcher's finger. The children were able to move independently on the chair, supported by the counterforce of water buoyancy (Becker, 2004). This strategy recognised by NDT and CE, advises the therapist not to touch or interfere with children with CP during independent performance of MP. Therefore, the TTC was designed to provide maximal movement at 360 degrees enabling free sitting practice without support.

Choice of the research tools was influenced by the treatment principles and theories selected for the study e.g. the Interval Recording Observation (IRO) (Table 5: No. 5) used a camera position enabling the researcher to capture the head position, an important variable during sitting. This strategy complies with the concepts of NDT, CE, PNF, Movement Therapy and Neurophysiological Approach (including HA and PAT) concerning righting of head position which all supported the eyes-head-body rule-principle of motion. Additionally, principles of Motor Control Theory and the Muscles Re-Education Model were applied (Phelps, 1941; 1941a). The latter model is based on strengthening musculature structure with body bracing and/or orthopedic support that controls limbs and joints and this influenced the establishment of the proper symmetry on the TTC with control, stability and fixation (Scherzer and Tscharnuter, 1990; Morris, 1997; 2004).

The Re-Education Model is criticised for not considering the plasticity (ability to recover) of the CNS. *'Many professionals were dissatisfied with the Muscle Reeducation approach. The plasticity (ability to recover) of the CNS was not considered, and patients with neurologic disorders often had more difficulty with patterns of movement and could not isolate specific muscle actions. This led to a general shift to a neurotherapeutic facilitation approach'* (Morris, 2004, p.153).

#### **2.4.4 Cephalo/Caudal- Proximal/Distal Directions**

The head position was emphasised in the chosen land-based and AT rehabilitation approaches in the present research, since *'normal postural control against gravity starts with head control and proceeds in a cephalo-caudal direction, and modification of limb movements proceeds from proximal to distal'*, as noted by NDT, (Bobath, 1984, p.85), PNF (Knott, 1967), Movement Therapy (Brunnstrom, 1970), Neurophysiological Approach (Huss, 1988) Motor Development (Rosenbaum et al., 2008; Shevell et al., 2008) and AT approaches. This strategy was employed for the child with CP during PIA sitting intervention.

## Fixation

Increasing the height of the TTC from the pool bottom creates a change in the ratio between buoyancy and gravity that affects the fixation of proximal body base of support: legs, pelvis and trunk when immersed below water level. The researcher assists the participant supporting the legs in the water to increase proximal base of support during the treatment sessions, enabling the children to stabilise sitting balance and engendering movement to the distal parts of upper extremities hands.

The design of the TTC was also influenced by fixation, stability and control models (Scherzer and Tscharnuter, 1990; Morris, 2004), and by the SACND and Goniometric research tools which guided the researcher to use a mechanical solution (TTC legs' support) to maintain the legs in a fixed position close to 90 degrees at hip, knees and ankles (Reid, 1997), at each elevation during treatments.

### **2.4.5 Balance**

Balance can be stationary or dynamic, but *'the most efficient patterns for balancing are classified as equilibrium reactions'* (Tscharnuter, 1993, p.23). Balance corrects the relationship between the centre of mass which is positioned over and aligned above the base of support (Scherzer and Tscharnuter, 1990; Tscharnuter, 1993; Reid, 1995; 1997; Howle, 2004; Hadders-Algra et al., 2007; Hatta et al., 2007 and Vekerdy, 2007).

Reid (1997, p.4) suggests that the child with CP will develop balance as *'the ability to shift body weight and resume midline orientation without hand support'*. This dynamic-reaching process is practised during PIA in AT-pool/land. This reflects a fundamental rule that suggested the need to employ a Goniometry evaluation of hip in static, passive and active ROM-stretching positions (Hazeldine, 1985; Rusling, 1988; Alter, 1996; Shelef, 1998; Clarkson, 2000). If the active ROM of trunk flexion is measured at the hip joint during sitting, and then when the child resumes midline sitting position with no help then a greater ROM should indicate better sitting balance, meaning trunk flexion would appear to improve sitting balance and reaching abilities (Sellers, 1986 in Reid et al., 1991; Trombly, 1995; Pope-Davis, 2001).

## Balance and Equilibrium in an Aquatics Environment

Balance and equilibrium principles are based on the theory of the Aquatics Meta-centre Concept or Bougier's Theorem (Becker, 2004; Vargas, 2004). The body balance is supported in water (sitting on the TTC), by the extent of buoyancy in immersion.

Buoyancy plays a major part in maintaining the body's free controlling balance in water (without support) during performance of trunk and upper limbs exercises through the water (Becker, 2004) which is altered by the shape and density of humans, particularly when parts of body are above water surface, when the result is a rotational response (Campion, 1998g).

The developed PIA, tested in this research combined AT approaches such as HA, BRRM and WA, using activities which benefit biomechanical factors associated with problems of balance dysfunction (Morris, 1997) since:

*... the pool is an excellent environment for working to improve the patient's ....equilibrium reactions. The fact that loss of balance occurs more slowly because of the higher density of the water and 'drag' effect allows the patient more time to react, so that there is a feeling of safety and better control is achieved* (Gray, 1998, p.208).

To conclude: *'water allows one to "dare to make errors", losing balance without the risk of pain or injury. Begin in deep water and work progressively to shallow water'* (Lambeck et al., 2004, p.84). As HA suggests, the PIA strategy of unloading joints and body toward loading (Harrison et al., 1992; Miyoshi et al., 2004) is a good vehicle to develop motor adaptation for people with CP, using the TTC.

#### **2.4.6 Free unsupported sitting**

Sitting position was chosen because: it is the most controlled position of the gross motor skills with less joints and balance involved in motion if compared to standing or walking. *'Sitting is the vertical antigravity posture halfway between lying and standing'* (Reid, 1997, p.3). The concept of treatment through free sitting without support on a flat horizontal seat-base (stool) is recommended by NDT (Scherzer and Tscharnuter, 1990, Tscharnuter, 1993; Reid, 1995; 1996; 1997; Hadders-Algra et al., 2007) and CE (Cotton, 1965; Cotton and Parnwell, 1967; Cotton, 1970; 1974) indicating the suitability of these two approaches for the present study's conceptual framework. This concept influenced the choice of research tools, data-collection and the planning/construction of a flat-seat TTC base.

Bobath and Bobath (1984, p.90) reported that:

*it was necessary to reduce our control gradually, handing it over increasingly and systematically to the child and so allow him control of his own movement especially of balance'. More recently NDT indicates that 'independent movements are all [that is] needed to achieve motor learning* (Howle, 2004, p.330).

The child learns to control the righting and regain balance without any interference, automatically, by himself (Bobath and Finnie 1958; Bobath and Bobath 1984; Scherzer and Tscharnuter 1990; Scherzer, 1993; Rosenbaum et al., 2008). In CE '*children are encouraged to work as independently as possible*' (Darrach, Watkins, Chen and Bonin, 2004, p.188). Thus, Peto explains that one must not prompt the child: '*the movements are guided by the child's own speech...the cortex controlling the movements*' (Cotton, 1965, p.438). Hari, (1997) suggested that the child needs to discover the solution for independent sitting which makes the child use learning processes: cognition and thinking. Peto calls it '*orthofunctional spontaneity*' (p.2), analogous to creativity. Functionality is taught in order to improve autonomous problem-solving, initiative and independence (Clarke and Evans, 1973; Shields, 1989; Sigafos, Elkins and Kerr, 1993; Stanton, 2002; Maguire and Sutton, 2005). Similarly, HA suggests that development of physical skills in water activities improves independent abilities (Martin, 1981; AST, 1992; Lambeck et al., 2004; Vargas, 2004; Sova, 2006).

The above approach contrasts with arguments that sitting therapy for bilateral spastic children with CP should focus on manipulations of the seat-base's tilting, inclination or sloped angles to improve posture with sitting and function (Mandal, 1976; Bendix, 1984; Lin, 2004; Stavness, 2006), or on supporting the child in any way during sitting with sophisticated supports and/or other stimulation or customised chairs (Letts, 1991; Myhr and von Wendt, 1991; Myhr et al., 1993, 1995; Akbayrak, Armutlu, Gunel and Nurlu, 2005; Hatta et al., 2007; Vekerd, 2007; Sagnol, Debillon and Debu, 2007).

As noted NDT, CE, HA and PIA suggest adopting an unsupported free independent sitting position on the flat horizontal base of a stool (Molanar and Gordon, 1976; McPherson et al., 1991; Trahan and Marcoux, 1994; Scrutton and Rosenbaum, 1997; Fedrizzi et al., 2000; Brogren et al., 2001; Miyazaki et al., 2004; Hadders-Algra et al., 2007).

Adopting this proposal meant that:

1. PIA in AT enabled the child to adapt to its environment, creating a process of change. Adopting theories from the Re-Education Model and Neurotherapeutic Facilitation Model, and the Motor Control Models strategy (Scherzer and Tscharnuter, 1990; Kurtz, 2002; Morris, 1997; Morris 2004; Vargas, 2004) indicated the need for the AT-cube sitting position practiced by HA (Cunningham, 1997; Lambeck et al., 2004; Vargas, 2004), WA (Dull, 1993; 1997; Dull and Schoedinger, 2004; Vargas, 2004), PAT (Petersen, 2004), and by the SACND tool on land. The cube position adapted to improve sitting posture required the conditions of flat horizontal stool with legs fixed at 90 degrees (Reid 1997). Combined with the RCPWB from unloading-toward-loading this position facilitated proper sitting,

functioning ability, symmetry, stability, fixation, balance, mental adjustment-adaptation, meditation and postural control in water or on land.

2. The consequent freeing of hands increased abilities, performance, manipulating skills and mastery of task activities demands, allowing the child to explore the world in a better way (Bobath, 1971,c; Lewin, Mix and Spira, 1993; Tscharnuter, 1993; Trombly, 1995).

#### Free Sitting without Support in an Aquatic Environment

As noted, NDT and CE advise the therapist not to touch the CP child during sitting treatment. In AT, one main *'force of buoyancy is an upward force [that] leads to important consequences in the therapeutic aquatic environment'* (Becker, 2004, p.23). Two forces control and act upon the body together, the force of buoyancy-upthrust and gravity-downthrust (Campion, 1998g). Thus, adding the developed TTC provided a sequence of phases, each time altering the relationship between the two forces (Lambeck et al., 2004), which facilitated the adaptation of the child with CP to sitting. *'The more the participant can practice the same skills in a variety of environments, the more they can generalise the skills to other situations'* (Lepore et al., 1998, p.12).

AT theory indicates a link between the phenomenon of sitting during physical immersion and benefit for motor physical adaptation and in turn for psychosocial domains. This is evidenced in the use of certain strategies used during immersed sitting and adopted by PIA. Eg. the cube sitting position, sitting on the therapist's leg or employing a 'Noodle' (flotation device) or a stool sitting in an AT immersed environment. All these strategies have been shown to improve adaptation of motor sitting skills through disengagement, postural control and enhanced sitting balance for general and special populations.

#### **2.4.7 Rhythmical Intention**

The reader is introduced to the Rhythmical Intention strategy by the Chinese proverb *'I listen and I forget, I see and I remember, I do and I understand'* (Pope-Davis, 2001, p.610).

Rhythmical intention\_developed by Professor Peto is defined as the mental preparation of a symbol display system in the cortex system toward intentional behaviour (Leon, 1987). It is a form of facilitation with two main purposes:

- to help make motion voluntary and active;
- to use rhythm (Hari and Akos, 1988; Sutton, 1988; Maguire and Sutton, 2005).

For example, counting provides the rhythm and 'hands above the head' constitutes the performance of the intention (Cotton, 1965; Cotton and Parnwell, 1967).

By combining the counting with the action, the child learns that counting can be used to put the body into proper posture (Cotton, 1965; 1970; 1974; Hari and Akos, 1988; Taylor, O'Shea, and Spira, 2007). Rhythm used with speech and movement promotes conscious self control of movement (Brown, 2005; Maguire and Sutton, 2005). The rhythm process connected to motion is accompanied by the child's speech in a Task Series (Taylor et al., 2007) to improve control of conscious intention e.g. *"I hold my ears", part of a task series, leads to ... "drinking out of a mug with two handles"* (Cotton, 1970, p.146). Similarly, NDT uses sensation, with inhibition and facilitation of MP in the context of the Task Oriented Approach (Howle, 2004; Ahl et al., 2005) or with a problem-solving approach involving neural and body systems and contextual factors (McBurney, Taylor, Dodd and Graham, 2003).

Task series involving Rhythmical Intention provided with positive reinforcement for effective functional movements, in carefully constructed goal-oriented learning situations to accomplish successful functioning, motivation, confidence and self esteem (Tsur, 1997; Brown, 2005; Maguire and Sutton, 2005; Taylor et al., 2007). This process was adopted in the present research using MCLT practice and experience (Ben-Phazi, 2009; Shalev, 2009), enhancing adaptation of children with CP to environmental demands.

#### Rhythmical Intention in the Aquatics Environment

HA used rhythmical intention with educational and recreational stimulation, enabling remedial, social adaptation processes and improved therapeutic benefits (Campion, 1998f; Lambeck et al., 2004; Vargas, 2004). BRRM gives the client short, precise commands relating to specific active movements, e.g. *'keep your body straight'* (Garrett, 1997, p.294). WA uses rotational manoeuvres without breaking the rhythm of movement which flows gracefully from one position to the next (Dull, 1997; Morris, 1997; 2004). PAT practicing rhythmic bobbing with dancing to tunes such as: *'Row, Row, Row Your Boat'* (Petersen, 2004, p.274).

In the PIA used to rehabilitate children with CP in water and on land in this study, treatment sessions included rhythms controlled by a metronome (Nakazawa, Yano and Miyashita, 1994; Ricken, Savelsbergh and Bennett, 2007; Zaino and McCoy, 2008, see Chapter 3: Methodology).

#### 2.4.8 Early Intervention

Because of the concept of CNS extra-plasticity and modification in cognitive, behaviour and motor systems during infancy (Howle, 2004; Feuerstein, 2007; Lombroso and Ogren, 2009; Shalev, 2009), early intervention has been advocated in order to prevent primary and secondary impairments.

Impairment is defined by the WHO (2007) as '*a loss or abnormality in body structure or physiological function (including mental functions)*' (p.229). Every disturbance developed has its expression in the CNS (Smueli, 2004).

Scholars from both NDT and CE approaches therefore recommend early intervention treatments for disabled children (WHO, 2007) as the most beneficial way to help the child with CP interact, experience, explore and adapt to the environment, developing the child's maximal potential ability (Pellegrino, 2002; Palisano et al., 2004; Damiano, 2006).

##### Early Intervention in Aquatics

AT offers a variety of rehabilitation techniques using water properties to improve activity limitations (Morris, 2004). For example, PAT intervention based on views of Campion (1998d); Mori (1998) and Petersen (2004), promotes vertical righting of poor head position with neck and trunk control against gravity, also improving sensory motor integration: play, body orientation, music, and songs. These activities are used to improve development and adaptation in physically, intellectually, socially and emotionally disabled children.

#### 2.4.9 Amount of Intervention

The parameters of optimal intensity (Meyer, 2009) duration and frequency of intervention used in the treatment of disabilities are not well defined for CP (Koury, 1996; Palisano et al., 2004; Fragala-Pinkham et al., 2009; Hutzler, 2009) in relation to the length, load and speed of motion (Campion, 1998d). These three variables have the most influential impact on the total amount of adaptation following controlled positive stress. *'It was suggested that the intensity of treatments could be a key variable in studies examining the efficacy of early intervention'* (Trahan and Malouin, 2002, p.233). The researcher's experience indicates that intervention and acquisition of skills should be practised on a daily basis, integrated within the daily curriculum, as can be seen in CE studies (Cotton, 1965; Cotton and Parnwell, 1967). In order to highlight the range and diversity of the different studies conducted in this field Table 1, attempts to equalise the intervention parameters and their frequencies presenting them by load per week and load per study to facilitate the reader's comparison of the data.



**Table 1: Differing Treatment Loads in CP Aquatics Studies**

<b>Authors</b>	<b>Group Size and Age</b>	<b>Study Design</b>	<b>Load per Week and per Study</b>	<b>Load Description</b>	<b>Results</b>
Peganoff, (1984)	n=1 14Y	Single Subject Design	2W=90M 8W=720M	Swimming Activities	Increase self-image, shoulder ROM, co-ordination, balance and equilibrium.
Dorval et al. (1996)	n=20 10.2-17.3Y	Non-randomised control trial QED	1W=55M 10W=550M	Swimming skills, exercises, aquatic games and relaxation.	Significant relationship between self-esteem, functional independence and aquatic activities.
Hutzler, Chacham, Bergman, and Szeinberg (1996)	n=61 4 - 7Y	Non-randomised Control trial QED	4W=120M 25W=3000M	Breathing and swimming skills with NDT exercises.	Significant improvement of VC and water adaptation including swimming.
Hutzler et al. (1998)	n=46 5 - 7Y	Non- randomised control trial QED	4W=120M 25W=3000M	Movement and swimming with land and NDT exercises.	Significant improvement of water adaptation including swimming. No effect on self-concept scale.
Hutzler et al. (1998a)	n=46 5 - 7Y	Non-randomised control trial QED	3W=90M 25W=2250M	Water adaptation with land and NDT exercises.	Reduction of lungs function and significant improvement in VC and WOS.
Vogtle, Morris, and Denton, (1998)	n=6 23 - 35Y	Multiple- Case Designs	2W=100M 7W=700M	Exercises of WA and HA.	Improvement of passive ROM, function, social experience and decrease in pain.
Shelef (1998)	n=18 7.9 -14.1Y	Non- randomised control trial QED	2.5W=75M 4W=300M	Aquatic passive stretching exercises	Significant improvement in CSTT and in group water treatment versus land treatment.
Thorpe and Reilly (2000)	n=1 31Y	Single Subject Design	3W=135M 10W=1350M	Lower extremity resistive exercise during walking.	Increased velocity of gait, GMFM score, strength, mobility, balance and self-perception.
Maynard (2004)	n=1 40Y	Single Subject Design	3W=90M 5W=450M	Water walking with resistive exercise.	Improved lower extremity strength and ambulation.
Thorpe, Reilly and Case (2005)	n=7 7-13Y	Convenience sample of ABA design	3W=135M 10W=1350M	Lower extremity resistive exercise on ambulation.	Significant improvement in GMGM and lower

Authors	Group Size and Age	Study Design	Load per Week and per Study	Load Description	Results
					extremity strength and gait velocity.
Getz et al. (2007)	n=22 3.8-6Y	Non- randomised control trial QED	2/W=60M 16W=960M	HA ten point system: Skill adjustment, Rotations and swimming skills.	AT significant improvement in perceived social acceptance and in PEDI caregivers in Social function domain when compared to land exercise group and improve in aquatic independence measure.
Ozer et al. (2007)	n=13 5-10Y	Randomised control trial QED	3/W=90M 14W=1260M	Swimming training skills and exercises Programme.	Swimming group significantly improved in body awareness domain.
Fragala-Pinkham et al. (2009)	n=4 ** 7 and 10Y	Case series with ABA design	1/W=30M * 9W=900M *	Water: kicking, balance, gait, running, swimming, strength, stretching and endurance activities. Land: Treadmill, karate, strengthening and stretching activities.	Case 2: Clinically significant improvements in gross motor function, balance, lower extremities ROM, strength, walking, ability to negotiate stairs, running faster and less effort in get up from floor. Case 3: Clinically significant improvements in movement from floor to standing, passive ankle ROM, 3 min fast walk and progress with walking skills.
Shelef (2010) Present study	n=5 10-15Y	Multiple-case designs ABACADA	4.8/W=225M * 13.5W=3037M*	PIA sitting exercises with ADL activities.	Improvement of passive and active ROM, sitting function, competence with quality of life.

## KEY TO TABLE 1

ADL	Activities of Daily Living	M	Minutes	QED	Quasi-Experimental Design	WA	WATSU Approach
CSTT	Connective Soft-Tissue Tightness	NDT	Neurodevelopmental Treatment	ROM	Range Of Motion	WOS	Water Orientation Score
GMFM	Gross Motor Function Measure (1993)	PEDI	Paediatric Evaluation of Disability Inventory	VC	Vital Capacity	Y	Years
HA	Halliwick Approach	PIA	Partly Immersion Approach	W	Week		
<p>* Fragala-Pinkham et al. (2009) and Shelef (2010) the present study, the load per week and per study are calculated as averages of the amount of total CP cases' treatment interventions.</p> <p>** In Fragala-Pinkham et al. (2009) out of n-4 participants just 2 were diagnosed as CP and included in this table.</p>							

### 2.4.10 Heat Principle

The efficiency and utility of water heat properties depends on availability of means for retaining and transferring heat energy, which occurs in three ways: conduction, convection and radiation.

The heat of the water enhanced by its relaxing qualities, induces and helps to reduce hypertonus and hypertonicity (Lepore et al. 1998; Hutzler et al., 1998a; Bennie, 1998; Kesiktaş et al., 2004) specifically for children with CP (AST, 1992; Bergman and Hutzler, 1996; Hutzler et al., 1998a). Therefore, heat applied in an AT environment enables children with CP to increase ROM (Peganoff, 1984; Shelef, 1998; Vogtle et al., 1998; Fragala-Pinkham et al., 2009).

Hypertonicity is the natural or biological compromise that allows an impaired CNS to accommodate itself to the environment. *'One may look upon spasticity as nature's first clumsy attempt to solve the problem of postural control against gravity'* (Bobath, 1984, p.80). Therefore water heat facilitates better adaptation when applied with RCPWB-(PIA), that reduces gravity conditions (Cole and Becker, 2004; Miyoshi et al., 2004) later carried over to land.

#### 2.4.11 Specificity of Movement

The 'Specificity-of-Training Principle' ((Morris, 2004, p.167) is a principle adopted from land treatments and used in water rehabilitation, to train the child for functional task activity (Ben-Pazi, 2009a; Hurvitz, 2009) including ADL and to practice these activities as a complete repertoire, in conditions as close as possible to the reality in which the child operates (Carr and Shepherd 1982; Winstein, Gardner and McNeal, 1989; Higgins, 1991; Koury, 1996; Morris, 1997; Schmidt and Wrisberg, 2004; Lennon et al., 2006).

In AT, Morris (1997; 2004) used the principle to develop his TTTA. The PIA of the present research applied the principle during sitting on the TTC using HHC for ADL activities in a developed environment, practicing skills and tasks identical to those practiced during sitting on land.

#### 2.4.12 Carry Over - to Gravity

In AT *'the ultimate goal is for the functional improvement to carry over to gravity influenced land activities'* (Morris, 2004, p.167; Fragala-Pinkham et al., 2009). The Carry-Over Principle was coined by Bobath, who suggested moving out of the treatment room into the field of parents and/or school (Rosenbaum et al., 2007). In the *'off loading body weight'* (Becker, 2004, p.44) environment, buoyancy supports trunk balance improving locomotion, ambulation, gross motor and task specific functioning (Morris, 1997; 2004). The research PIA diminished immersion in a sensitive graded manner, *'allow[ing] controlled loading'* (Campion and FitzGerald, 1998, p.285), to practice child's adaptation capabilities, while gradually increasing gravity.

The HA *Ten-Point Programme* uses task-type training approach in AT which later enhances land skills (Cunningham, 1997; Lambeck et al., 2004). E.g. balancing skill used in stillness activities in water benefits in-function postural stability on land (Morris, 2004). This strategy was applied with the developed PIA. The rehabilitative combination of both environments might show positive outcomes.

### 2.5 Enhancing the Psychosocial Domain

#### Competence

A scholarly consensus from different fields asserts that play is a symbolic act in which young children can act out situations to develop competence mechanisms and to adapt to task performance, enabling them to master new skills or enhance skills they cannot perform in

the real world (Gesell and Ilg, 1946; Erikson, 1950; Piaget, 1962; in Harter and Chao 1992; WHO, 2007).

White (1971 in Hopkins, and 'Tiffany, 1988) considers successful experience as a manifestation of 'effectance motivation' (White, 1959; Vermeer, 1992) namely the motivation to interact competently with the world, while 'motivation' is defined by the WHO (2007) as: *'mental functions that produce the incentive to act; the conscious or unconscious driving force for action'* (p.51).

Behaviours such as innate curiosity, investigation, play control, skill development, success or failure experienced during acquisition of mastery, anxiety, and a need to interact with the environment, are all impulsive expressions of competence (Harter, 1978; Bandura, 1982; Hopkins and 'Tiffany, 1988). 'Competence' is defined by White (1959 in Shanon, 1988) as the *'capacity to interact effectively with the environment'* (p.147) or *'to be competent means to be sufficient or adequate to meet the demands of a situation or task'* (White, 1971 in Shanon, 1988 p.147; Vermeer, 1992; Čurdová et al., 2001).

Social Cognitive Theory (SCT) (Bandura, Barbaranelli, Caprara and Pastorelli, 2001) also claims that the exercise of personal competencies may put a person at risk of failure if the person's impairments hinder performance when adaptation is essential in order to meet environmental demands e.g. if a person has to bend to get inside a car.

Thus, within the context of CP learning movement, the need to respond to the demands of the environment, challenges the individual to develop motor skills so that voluntary 'functional activities for self-help' can be applied to ADL (Bobath, 1972, p.25; Bobath and Bobath, 1984; Scherzer and Tscharnuter, 1990; Maguire and Sutton, 2005; Blank, von Kries, Hesse and von Voss, 2008).

The 'differentiated model' of the self proposed by Harter (1985; 1988) suggests two aspects of the self concept: GSW also known as Self Esteem is a process of general psychological and social functioning. Based on the child's self-awareness and the way the child perceives its identity in relation to others, it is not domain-specific, but relates to a variety of domains. (Harter 1985; Schuengel et al., 2006; Shields, Murdoch, Loy, Dodd and Taylor, 2006). Second, Perceived Competence (PC) is *'defined as the personal impression of one's own ability in each domain'* (Harter, 1978 in Getz et al., 2007, p.218). It is a domain-specific construct, since children do not usually feel equally competent in every skill domain (Hutzler et al., 1998; Schuengel et al., 2006), while the degree of PC determines the degree of motivation (Hutzler et al., 1998; Čurdová et al., 2001; Maguire and Sutton, 2005). This model was adopted for the present study.

### 2.5.1 Perceived Competence and Overcoming Fear

People fear effects of threatening situations which they believe exceed their coping skills; e.g. the sitting inability of people with CP (Howle, 2004; Boyd, 2004). Bandura et al. (1975). Bandura, Adams and Beyer (1977) believed that PC reduces anticipatory fears, since it engenders expectations of success which help to sustain coping efforts in time of difficulties. Self-confidence and PSE improved by independent achievements reinforce the sense of success. Acquisition of skills improves PC, self-adequacy, and a sense of efficacy, leading consequently to better coping as well as eliminating fear in provocative situations. Treatment that improves behavioural functioning and produces successful experiences reduces fear, improving self competency (Bandura et al., 1975). The stronger the PSE and/or task accomplishment expectations the more active a person's efforts will be when dealing with unfamiliar threats (Bandura et al., 1977). This process protects and empowers people in general (Ozer and Bandura, 1990).

#### Empowerment, Motivation, Adaptation

Bandura or SCT (1986) claimed that the degree of PSE can be improved as a result of personal attainments in tasks performance. Consideration of the effects of PSE and PC play a major role in establishing empowerment strategies (Bandura, 1986; Hutzler, 1990), which enable the child with CP to become active in rehabilitation (Miller and Reid, 2003; Harris and Reid, 2005; Blank et al., 2008). Empowerment affects knowledge, skills, self-efficacy (Ozer and Bandura, 1990), successful performance, improved self confidence (Bandura et al., 1975; Bandura, 1982) and motivation in AT (Fragala-Pinkham et al., 2009). Empowerment is also used in FCS (King et al., 2002; 2004); affecting human adaptation by improving motivation, self management and general functioning (Bandura et al., 2003).

Using similar concepts to PSE, PC, Empowerment and FCS, CE advocated pre-conditions for success e.g. using pleasant atmosphere, appropriate grouping, fun, motivation, clear goals, to enable life-long adaptation to the environment (Brown, 2005; Maguire and Sutton, 2005; Taylor et al., 2007).

#### Quality of Life (QOL)

QOL *'deals with what people "feel" about their health condition or its consequences; hence it is a construct of "subjective well-being". On the other hand, disease/disability constructs refer to objective and exteriorised signs of the individual'* (WHO, 2007, p.264). This subjective view is a good indicator of social and emotional adaptation (Albrecht and Devlieger, 1999 in Majnemer, Shevell, Law, Rosenbaum and Poch guides behaviour and includes many dimensions (Schmidt and

Bullinger, 2003; Rosenbaum, 2007). 'Well being' is defined as '*the total universe of human life domains, including physical, mental and social aspects*' (p.227).

Health Related Quality Of Life (HRQOL) is an evaluative concept describing a subset of QOL and relating to a persons' health, (Spilker and Revicki, 1996; Bjornson and McLaughlin, 2001) and helps to evaluate the impact of a health condition on the person's QOL (Rosenbaum, 2007).

The importance of both terms, (QOL-subjective and HRQOL-objective) is that they can be used to indicate effectiveness of outcome of treatment progression for CP and therefore should form the goal of clinical intervention (Schneider, Gurucharri, Gutierrez and Spira, 2001; Waters, Maher, Salmon, Reddihough and Boyd, 2005; Nemer, Blasco, Rossman and O'Malley, 2006; Shelly et al., 2008).

The extent of the gap between subjective concepts of experience and expectations provides an appropriate way to measure personal QOL (Moons et al., 2006). '*The WHO refers to the individual perception of their [the children with CP] position in life in the context of the value system in which they live and in relation to their goals of expectations, standards and concerns*' (Rosenbaum, 2007, p.57).

This study chose to solve the debate relating to objective-person and subjective-caregiver views of QOL in reports of children with CP by integrating both self-reports and proxy-reports to provide the richest, most objective and updated data possible (Varni et al., 2005; 2006; White-Koning, et al., 2007). It also adopted the strategy used by Waters et al. (2005) who developed QOL themes and attributed them to WHO (1993) domains. Similarly, Young, Rice, Dixon-Woods, Colver and Parkinson (2007), matched qualitative categories with KIDSCREEN (2006) dimensions, as the present study does, but the present study related to a larger combination of QOL domains, employing a larger variety of research tools.

### 2.5.2 Models of Disability and Quality of Life

Therapeutic models often combine characteristics from different domains to measure improvement of satisfaction in FCS, health, disability, well-being and QOL (Graves, 1995; Rosenbaum, 2004; D'Amato, Hobson, Huang and Geil, 2005; Elder et al., 2007; Perrin et al., 2007; WHO, 2007) after intervention.

Enablement Models perceive individuals as able to deal with their difficulties by taking responsibility (King et al., 2002; Palisano et al., 2004; WHO, 2007). Specifically, NDT<sup>1</sup> uses an Enablement Model (Bickenbach, Chatterji, Badley and Uston, 1999; Howle, 2004) based on ICF-CY, Table 1: (WHO 2001 and 2007, p.10) to form a guideline framework combined interactions of 'person' and 'task' aspects with a spectrum of outcomes (Howle, 2004; Rosenbaum et al., 2007).

Yet, all relevant theories (BBM/IPT, NDT, FCS, DST, CE and MCLT) agree that disability is also affected by both 'intrinsic body systems', including a persons' beliefs, attitudes and coping strategies and 'extrinsic environmental systems' conditions or contextual factors.

#### The WHO Classifications

The International Classification of Impairments, Disabilities, and Handicaps, (ICIDH) published by the WHO, (WHO, 1980 in Vermeer, 1992) categorises disease and intervention programmes, later redefined by ICF-CY (WHO, 2007).

There is scholarly consensus that the WHO (1980; 2007) definitions facilitate evaluation of physical improvement in physically disabled populations following rehabilitation intervention (Vermeer, 1992) and provide criteria regarding full participation in all life domains (Dechesne, 1985 in Vermeer, 1992; McBurney et al., 2003; WHO, 2007).

#### Consideration of Psychosocial Aspects in Aquatics Therapy

De Vierville (2004, p.1), reminds us that '*Aquatic rehabilitation is a...term that describes a scientific theory, a medical rationale, and a set of clinical procedures using water immersion for the restoration of physical mobility and physiologic activity, and, at times, for effecting psychological transformation*'.

Thus, there is a connection between the phenomena of physical water immersion and the benefits for motor physical adaptation and effects on psychosocial domains.

Despite theoretical propositions supporting the benefits of AT activities for the physical development of children with CP (Sherrill, 1993, Campion, 1998e; Getz et al., 2007), little research and documentation is available on pediatric therapy and/or its effects on their psychosocial welfare (Dumas and Francesconi, 2001; Becker, 2004; Kelly and Darrah, 2005). AT rehabilitation has been shown to enhance self-confidence, morals, motivation, self



esteem, body image, socialisation, independence, motivation and self-reliance, which all influence successful recovery (AST, 1992; Morris, 1997; Chmpion, 1998a and f; Lambeck et al., 2004; Vargas, 2004; See Appendix 8: Table 1: Aquatics Studies demonstrating Psychological Benefits for CP Populations

No studies were found which related to interventions in combined water and land (PIA) conditions for CP participants with positive effects on GSW, PC and QOL, as practiced in the present research. Similar attempts were conducted by Hutzler et al. (1998) Getz et al. (2007) Ozer et al. (2007) and Fragala-Pinkham et al. (2009) but were without significant results.

## 2.6 Summary

*There is evidence to indicate that aquatic therapy has numerous psychological and physical benefits. Furthermore, aquatic therapy appears not only to improve physical and psychological functioning, but also maintain health and daily life functioning (Broach and Dattilo, 1996, p.226)...Further, the general consensus reported in the literature is that aquatics is a viable medium that has potential to enhance quality of life for people with disabilities (p.214).*

This potential was realised in present research.

## 2.7 The Gap of Knowledge

Wisker (2008) explained that the '*gap in knowledge that your work will fill* [provides] *the boundaries to your work*' (p.58). This study aimed to address such gaps in relation to: AT-water, land-based therapy, psychosocial competence and QOL of children with CP.

### Aquatics Therapy-Water

The PIA of this study employed 30mm maximum elevation phases from an unloading to a loading environment, (other options considered e.g. 60mm lift twice a week in the pilot study, were found too stressful for participant's successful adaptation) while current AT studies (Harrison and Bulstrode, 1987; Harrison et al., 1992; Nakazawa et al., 1994; Fowler, 1997; Miyoshi et al., 2004) use the RCPWB option in a very crude manner (Appendix 2: Figures: 2, 6 and 11 (2-11)), an uncontrolled '*progression including moving to more shallow portions of the pool*' (Maynard, 2004, p.24), reflecting present AT rehabilitation approaches (Koury, 1996, Campion, 1998e; Morris, 2004; Fragala-Pinkham et al., 2009), that neglected the difficulties of children with CP, using activities of standing/walking rather than sitting, and failing to emphasise the adaptation process-the paradigm of current research.

## Land-based Therapy

DST indicates that it is possible to engender reorganisation of the individual's sub-systems in order to produce a more integrated form of behaviour (Thelen and Ulrich, 1991; Smith and Thelen, 2003). Thus, DST and EA both advocate the need to identify variables or subsystems which trigger a total system change (Deitz Curry, 1998). This is a gap in knowledge which this study aimed to fill in relation to the adaptation of the system of the child with CP system to its environment.

Similarly, NDT (Howle, 2004) focused on the environment-gravity variable and the influence of environmental laws (e.g. gravity support surface and friction) on the body system (e.g. muscles power, body mass, biomechanical properties) and task characteristics (e.g. predictability, meaningfulness). As noted, this environment is a 'product' of the degrees of freedom (Bernstein, 1967), that open the '*gravity environment*' (Morris, 2004) to enable '*buoyancy-supported antigravity work*' to be performed (Petersen, 2004, p.252). Very little research work has been conducted to discover whether manipulations of environmental conditions (gravity) can consequently cause changes in the body system and task characteristics. The present research aimed to fill this gap in knowledge.

Additionally, there has been little research to validate or to reaffirm the assumptions of IPT, that change in the extrinsic environment facilitates change in the intrinsic-organism systems. This gap in knowledge is especially evident in the application of RCPWB in rehabilitation of physical disabilities. It is hoped that the present research helps to clarify this issue.

The gap in knowledge in relation to MCLT, focuses on the consideration of children with CP who have '*poor motor control of posture*' (Zaino and McCoy, 2008, p.143). The gap addressed in this field is how to initiate controlled planned feed-forward or to regulate anticipated adjustments of MP (Howle, 2004; Palisano et al., 2004). This research therefore wanted to examine whether PIA using RCPWB, could improve the child's motor adaptation to the environmental context on land.

Another gap investigated: McAvoy (2006) suggested that certain therapeutic activity benefits more from water treatment while other activity benefits more from land treatment. however, there is a lack of extant evidence relating to the validity of this suggestion. The EA has also accumulated little evidence regarding the effect of different environments (water versus land) on the development of functional skills in children with CP. The present research investigated to what extent water was more beneficial than land or not and whether skills abilities developed in water could be transferred to the land environment and thus added knowledge in this area.

### Psychosocial Competence

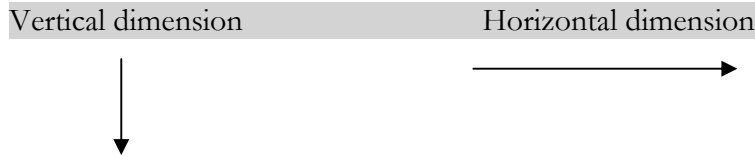
The *'mood state has been found to improve after dry land exercise, but relatively little work has been done on this issue in an aquatic environment'* (Becker, 2004, p.51). Indeed, combined AT-water and land mixed treatments that might improve psychosocial adjustment of the life domains and QOL of children with CP do not appear in the professional literature.

### Quality of Life

Despite the rich abundance of QOL research involving populations with CP on land, no longitudinal study was found that examined stability of QOL domains for this population over time (Majnemer et al., 2007; Livingston, Rosenbaum, Russell and Palisano, 2007; Rosenbaum, 2008) and in particular there were no 12 months follow-ups in relation to improvement of QOL following AT, or follow-up studies relating to intervention in combined water and land environments.

### Moving from the Factual Level to the Conceptual Level

Trafford and Leshem (2002) and Abrahmov (2008) offer a conceptualisation of thinking at the level of a doctorate degree. They suggest three sequential progressive thinking levels (factual, interpretative, and conceptual) that are controlled and triggered by the RQs. In this study RQs 1 and 2 relate to the factual PIA intervention, leading directly to RQ 3 that relates to the interpretation of the factual level and the effect of the intervention on the intrinsic psychosocial systems. The process concludes with RQ 4 -the conceptual level where the QOL of the child with CP is considered. This process can be understood by relating to the two dimensions of Table 2 below.



**Table 2: The Research Questions that led the research from the Factual to the Conceptual Level in relation to Different Disability and Rehabilitation Models**

The Current Research Questions relate to:	ICIDH Definition	ICF Definition	Bangma Model in Vermeer (1992) CP condition expressions	White's Model (1987 in Vermeer, 1992)
PIA improved sitting	Impairment	Body functions and structures	Chronic Neurological Disturbance	Effect on Motivation
Sitting improved then hand-head coordination skills	Disability	Activities and participation	Coordination Disturbance necessitates Motor skill learning	Mastery of Attempts
Improved function of motor skill competence	Physical Handicap	Environmental Factors	Lack of perceived competence necessitates strengthening of perceived competence	Success in movement: skills Competence
Improved QOL.	Socio-Economic condition	Personal Factors	Negative perception of social role necessitates prevention of handicap	Pleasurable feeling-boosts motivation

The RQ related to the two different axes of Table 2: **First**, Partial Immersion Approach (PIA) intervention strategies and evaluation methods were implemented at each International Classification of Functioning - Children and Youth Version (ICF-CY) level (Vertical dimension). In the horizontal dimension, an ordinary effect relationship linked the RQ with ICF definition levels and the Cerebral Palsy (CP) conditions, (Bangma Model) and the necessary emotional, psychosocial skills (White's Model). **Second**, each column also progresses vertically downwards in orderly progression. The RQ were the trigger linking the four levels. At the WHO-ICF (2007, p.10) 'Body Functions and Structures' level, the RQ relate to rehabilitation of chronic motor dysfunction during sitting, at the 'Activities and Participation' level, the RQ focus on learning HHC skills, at the 'Environmental Factors' level, the RQ relate to consequent improvement of skill competence, and at the 'Personal Factors' condition level, to improvement of QOL.

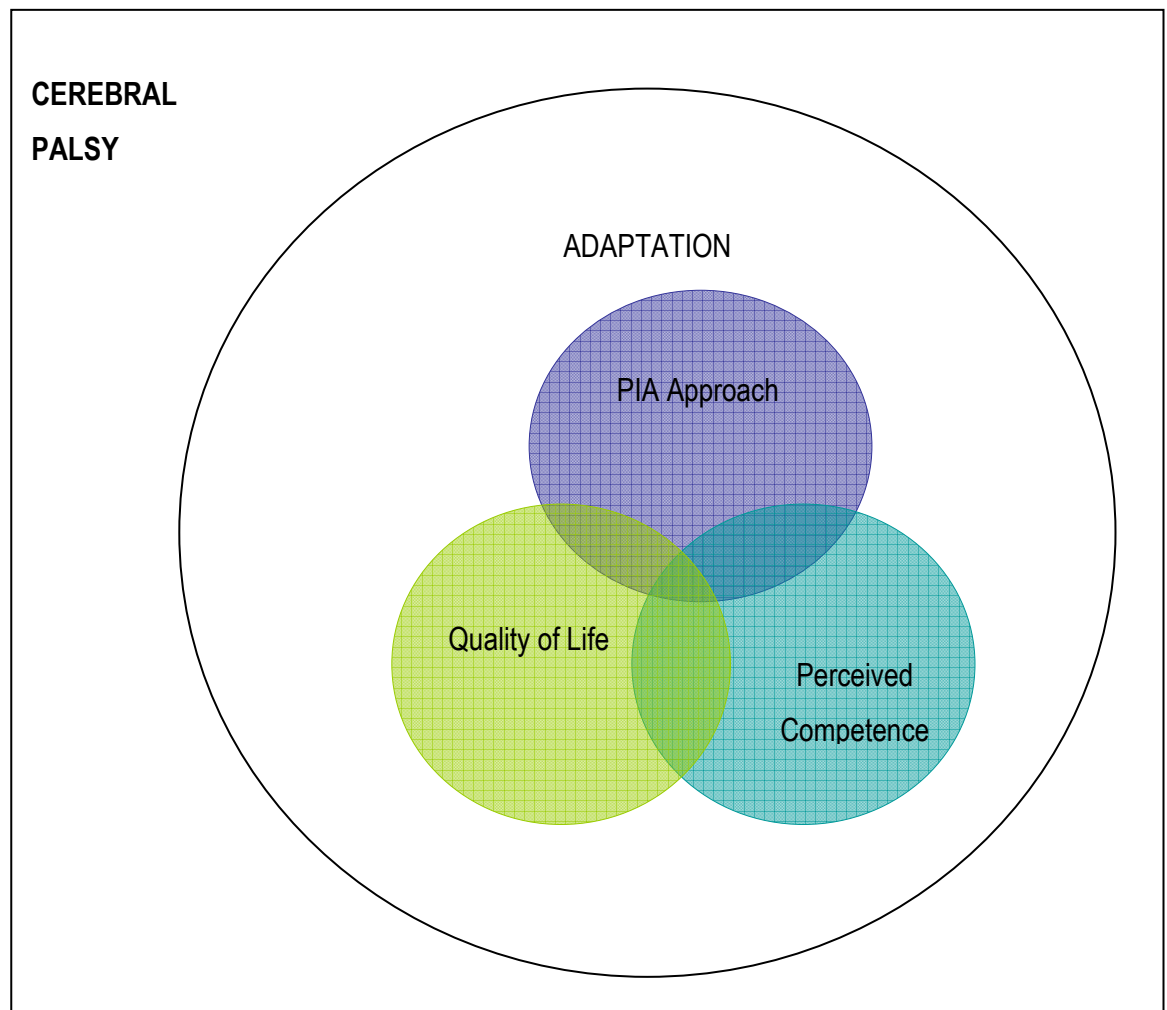
Similarly, (horizontally) the RQ determined the interpretation of collected data in correlation with the different levels of severity according to ICF classifications and in line with the different levels indicated by the Bangma Model that describes the levels of CP condition and White's Model. The research developed according to the sequence of RQ, through the stages of the intervention and the gradual improvement of the participant's status, during motor skill activities (vertically), thus positively influencing motivation until pleasurable feelings were achieved which again boosted motivation (White's Model).

The process reflected in Table 2 indicates that improving motor skills adaptation is meaningful for effective progressive development (Vermeer, 1992; Vermeer, Lanen, Hendriksen, Speth and Mulderij, 1994; Darrah, Wessel, Nearingburg and O'Connor, 1999) in both physical and other domains of adaptation such as PC (Schuengel et al., 2006; Blank et al., 2008; Gorton et al., 2009), or the social domain (Bobath, 1963a; Čurdová et al., 2001; Van Der Burg, Jongerius, Van-Limbeek, Van-Hulst and Rotteveel, 2006; Verschuren et al., 2007). However, there is an opposing view suggesting non-correlation between improved physical function and psychosocial well-being (Dodd, Taylor and Graham, 2004; Pirpiris et al., 2006).

Nevertheless, returning to Darwin's biological view as explained by Romanes (1895) all species *'inherited the particular adaptations derived from [a] common ancestor, while progressively gaining additional adaptive characters severally distinctive of their subsequently diverging lines of descent'* (p.163). This may reinforce the view that *'domains of functioning [physical adaptation]...have the strongest influence on global self-worth'* (Schuengel et al., 2006, p.1251), and there is therefore a possibility that improving physical achievements may engender change and improvement in other domains of adaptation, such as GSW. But the question remains open-does this process occur in children with CP? The present study attempted to answer this question.

The next section explains the conceptual framework on which the research was founded.

## 2.8 The Conceptual Framework



**Figure 1: The Basic Concepts underlying the Conceptual Framework of the Study**

The proposed PIA tested in the research was conceptualised with the assistance of these theories: Systems Theory, DST, FCS within EA, MCLT, IPT, Development Theory and approaches: NDT, CE and AT: HA, BRRM, WA, TT\*TA and PAT, which were employed to explain the fact that intervention relating to one subsystem (Howle, 2004), that reduced gravity through RCPWB in the water environment, facilitated improvement of functional motor adaptation and in turn produced enhanced adaptation of other human domains e.g. GSW, PC, SCT, PSE, empowerment and motivation finally achieving an enhanced QOL for children with CP.

The integration and connection of parts of theories can be accomplished in different ways according to: categories, themes, issue, principles etc. In the present study parts of theories and principles were interfaced with motor adaptation paradigms, and formed the foundation

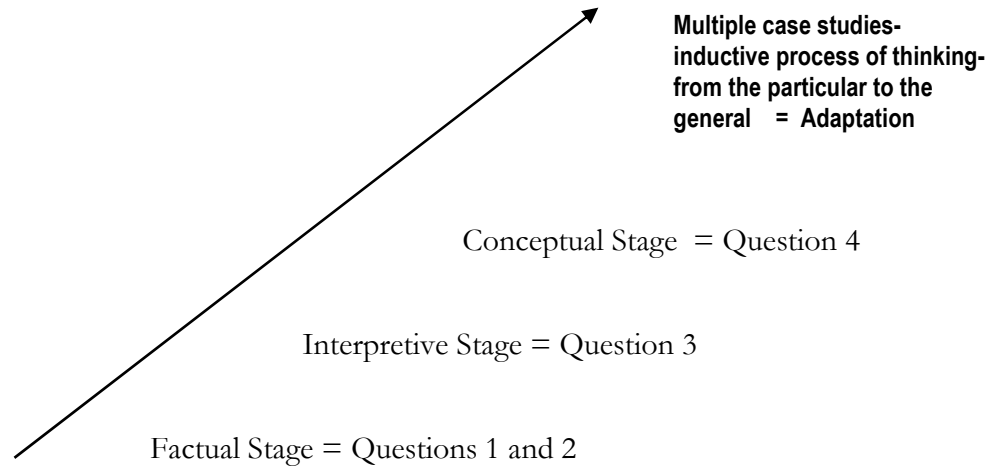
for the development of the PIA intervention including an innovative form of TTC. These theories and principles also underpinned the choice and delineation of the research questions, aims, boundaries, appropriate methodology and process to fit the special context of the research phenomena and enabled the researcher to answer the RQ through a cohesive adaptation paradigm and to attain the research goal, eventually producing new knowledge and contributing to knowledge in this field.

In mathematical form this would be:

$$\begin{aligned}
 &X \quad (\text{improved intervention filling Gap in Knowledge-factual action}) \\
 &+ \quad (\text{Conceptual framework}) \\
 &Y \quad (\text{Appropriate methodology}) \\
 &= \quad (\text{Results and conceptualisation of process}) \\
 &Z \quad (\text{Conclusions: PIA=better theory plus Contribution to Knowledge}).
 \end{aligned}$$

## 2.9 The Research Questions addressed by the Research Design

The RQ were used to link the research stages and test whether the developed PIA improved the motor function adaptation of children with CP-the initial intervention, and consequently enhanced the children's perceived QOL.



**Figure 2: The Inductive Thinking Process**

### 2.9.1 From Factual to Conceptual: The Cause and Effect Relationship

If Question 1 is answered positively (i.e. the child with CP is able to sit independently) it is then possible to progress to Question 2 (achievement of hand-head coordination during sitting) and then progress to Question 3 (improvement of PC adaptation) and subsequently to Question 4 (improvement of QOL). If all questions are answered positively a Contribution to Knowledge is achieved, with potential for generalisation.

The factual observable micro-level phenomenon provided the answers for the first and second RQ examining improvements in child's motor function adaptation. This area was previously neglected in relation to children with CP (Bobath, 1963a,b; 1971,c; 1974; Brown, 1997; Hari, 1997; Howle, 2004; Liptak, 2008).

The second interpretive level, could not be observed. At this level interpretation was applied to the findings to provide meaning for the factual level. At this level improvements in the child's intrinsic psychosocial domains were verified in line with a synthesis of the models of the ICIDH/ICF (WHO, 1980; 2007), Bangma (1989) and White (1987 in Vermeer, 1992).



At the third universal meta-conceptual level the researcher conceptualised unexplored elements and tested them for their relevance to extant theory. This was represented by investigating whether the improved PIA enhanced the child's subjective QOL in the context of their own values and with relation to their goals and expectations (Rosenbaum, 2007; WHO, 2007).

An inductive thinking process was conducted through the RQ that guided the progress of the research process from the factual to interpretive and to the conceptual level although it was noted that, *'the researcher to be versatile and competently switch inductive and deductive positions according to the need of the study'* (Morse and Niehaus, 2009, p.20).

Yin (2003) indicates that this type of research question sequence is used with the case study strategy and also with deductive thinking.

*'if you needed to know "how" or "why" the program [PIA] had worked (or not), you would lean toward either a case study or a field experiment' (p.7)...[focusing on] 'the relationship of events over time' (p.127).*

Employing a triangulation strategy improved the study's internal validity and reliability which might otherwise be considered problematic due to complex issues: small amount of participants, complexity of children with CP and their sitting phenomena and difficulty involved in measuring sitting position during clinical evaluation. Figure 3 below explains the process by which the conceptual framework was woven through the various relevant theories and techniques.

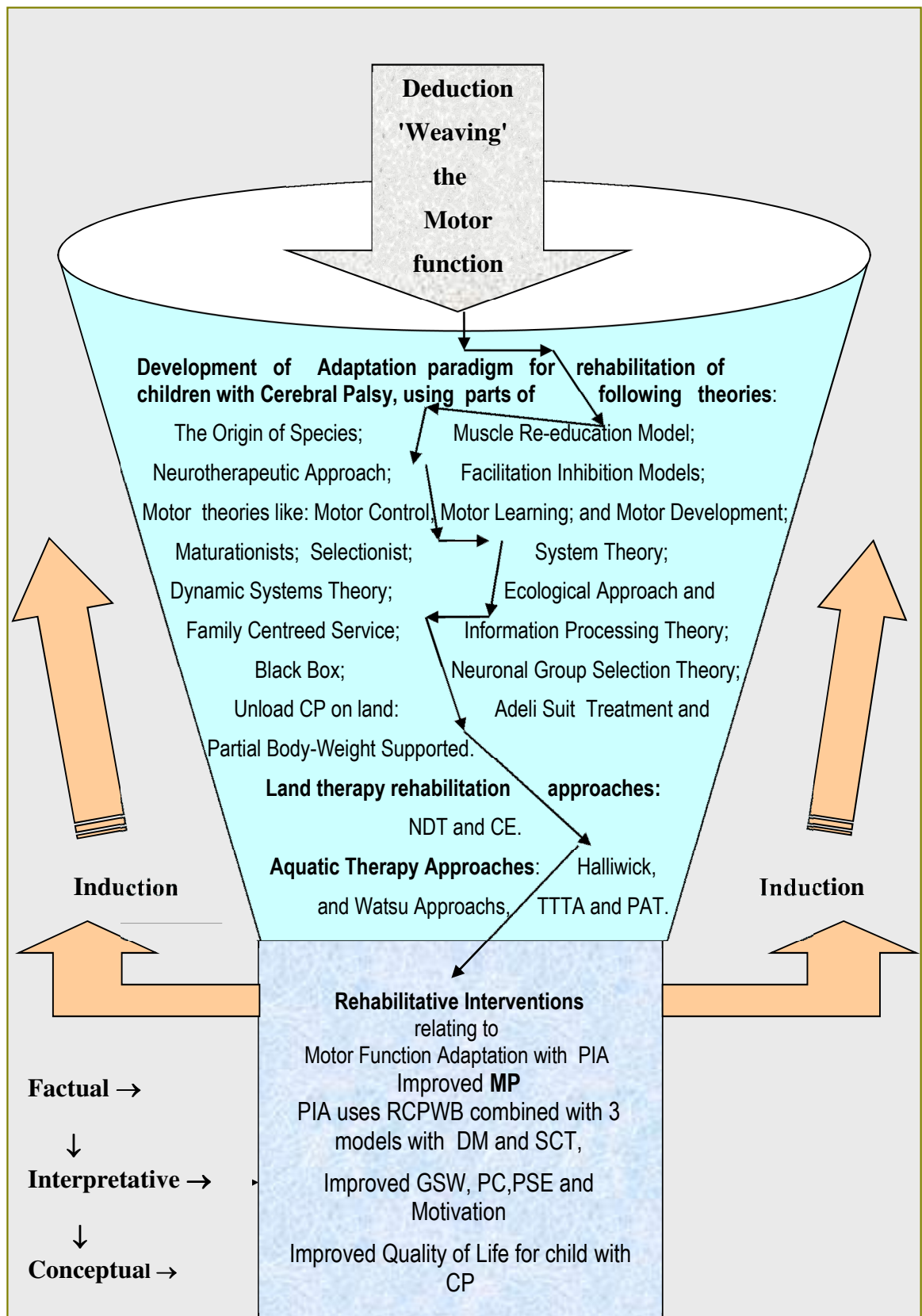


Figure 3: Adaptation Paradigms - 'Weaving' the Conceptual Framework

KEY TO FIGURE 3

BRRM	Bad Ragaz Ring Method	GSW	Global Self-Worth	PAT	Pediatric Aquatics Therapy	PSE	Perceived Self-Efficacy
CE	Conductive Education	MP	Movement and Posture	PC	Perceived Competence	SCT	-Social Cognitive Theory
DM	Differentiated Model	NDT	Neurodevelopmental Treatment	PIA	Partly Immersion Approach	TTTA	The Task Type Training Approach

As noted, in Figure 3 above, the theoretical foundation for this research was 'woven' through the various reviewed theories. The fine black arrows progressing downward through the funnel trace the deductive process of discovery from the general-wide to the particular-narrow, leading from parts of pure adaptation theories, a process that improved conceptualisation of the studied issues to develop a cohesive adaptation paradigm. The adaptation paradigm evolved as it passed through and was enriched by each theory, so that the final developed PIA represents characteristics of each theory.

These theoretical foundations formed the basis for the conceptualisation of rehabilitation for the children with CP beginning with a definition of the CP condition, and relying on the fundamental focus of both NDT and CE treatments strategy on '*Movement and Posture*' (MP) (Bax, 1964, Rosenbaum et al., 2007a, p.9).

As is seen in the cube at the base of the cone in Figure 3 MP was the concept that underpinned the scientific clinical intervention indicating the need to focus on the effect of the reduction of gravity conditions - using challenging opposite vector-buoyancy which the researcher manipulated and regulated. The resultant PIA rehabilitative intervention was used to investigate an attempt to improve the ineffective adaptation of people with CP that causes their defective functioning. The experimental treatment applied aimed to improve MP, an area of difficulty for people with CP that had previously been neglected. Additionally it was hypothesised that the improvement of motor-ADL functioning adaptation could trigger appropriate adaptation in other additional intrinsic domains (GSW, PC, PSE and Motivation). In practical factual terms the intervention involved the application of RCPWB in phases of 30mm decrease in immersion causing an increased gravity load each week for the child with CP, thus facilitating MP. This strategy forms the research's main contribution to the existing gap in knowledge in this field.

In Figure 4 below, the inception of the study's theoretical foundation is marked by black arrows leading diagonally from a broad base of existing theories toward the narrow central

area indicating the deductive process that led to the cohesive motor adaptation paradigm that guided the research intervention. The results of this intervention were interpreted through an inductive process - from the particular: motor adaptation paradigm outwards to the general: conclusions that formed the basis for the addition to existing theory, (see arrows leading diagonally outwards from the narrow central area to the wider sides). This inductive interpretation process indicated that improved physical functioning adaptation may trigger adaptation processes in other different domains (Getz et al. 2007). This led to a more universal level of conceptualisation; i.e. the possibility of achieving enhanced QOL for the child with CP, thus improving theory relating to adaptation.

This contribution to extant knowledge can, in turn, initiate the evolution of a new cycle of research and discovery relating to other CNS impairments populations and/or other types of interventions (similar to the PIA with TTC employed here) to improve the QOL and/ or life expectancy of people with CP and other populations.

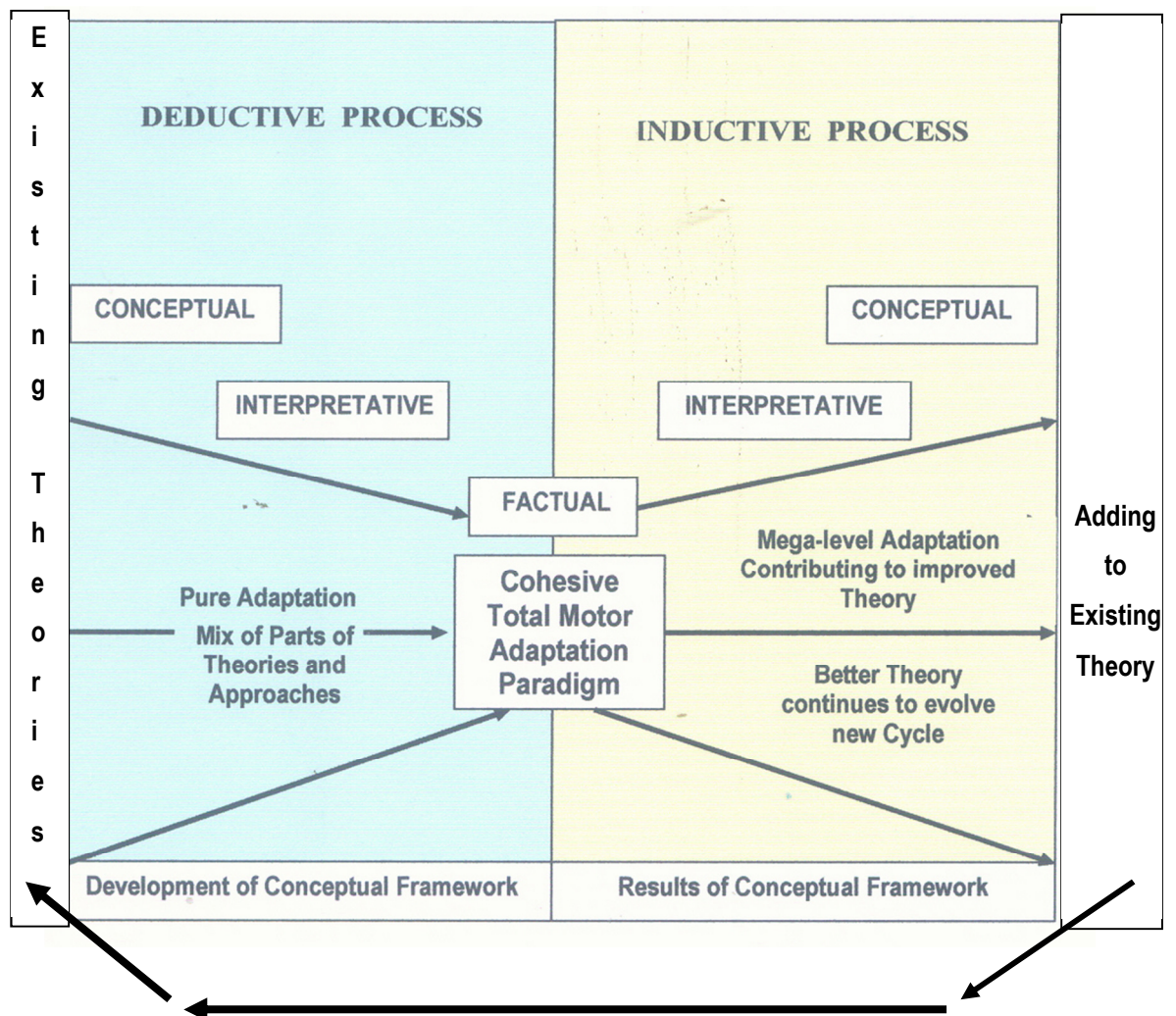


Figure 4: From Parts of Theory to Better Theory

## **2.10 Adaptation Summary**

The pure adaptation paradigm began with a review of parts of theories relevant to the phenomena it aimed to improve. This review enabled the researcher to develop and shape the conceptual framework, in which each theory influenced the addition or deduction of items in order to select the best most appropriate treatment intervention. The intervention that followed triggered improvement in other adaptation fields, shaping adaptation through the consideration of: task, goals, aims, child with CP, family, environment and culture. Through this process, a new PIA was constructed that could contribute to extant theoretical knowledge (Figures 3 and 4).

The conceptual framework bound together the different part of the thesis and the therapeutic action programme, linking extant theories to improved theories. Finally, it helped the researcher to create, defend and explain the rationale for the research action and thinking.

## **2.11 Chapter Summary**

This chapter surveyed the literature relating to relevant theories, approaches and principles underpinning the research. It outlined the conceptual framework of the research based on these theories and principles. The next chapter examines the methodology used to apply this conceptual framework to the practical work of the research and data collection, it explains the ways in which the data was interpreted and how its validity was reinforced.

## **CHAPTER THREE:**

### **RESEARCH PLAN AND METHODOLOGY**

#### ***Precis***

The previous chapter described and discussed parts of theories, approaches and principles that contributed to the conceptualisation of the developed Partially Immersed Approach (PIA) tested in the present research. It also presented the conceptual framework of the research and the questions that the research wished to examine.

This chapter now explains the research plan and process. It describes the four stages of the research and the considerations that the researcher took into account in selecting the research methodology impetus. It outlines the research framework and explains the research paradigm, methods and tools indicating the characteristics of the research population and the ways in which the research data was collected and analysed. Each research stage is then described in detail. Finally it considers the issues of validity, reliability and credibility, and explains ethical considerations involved in the present research.

Note: All references to the Researcher's Diary are given in order of relevance to subject context and not necessarily in chronological order.

#### **3.1 Introduction**

The research aimed to develop a novel PIA (Harrison and Bulstrode, 1987; Harrison et al., 1992; Fowler, 1997; Salzman, 2009), and to test whether it could be applied with effective results for rehabilitation purposes to improve the adaptation of children with CP during sitting and functioning in an AT environment, then carry over these achievements to the child's land environment.

#### **3.2 The Research Hypothesis**

The researcher hypothesised that rehabilitating the sitting MP of children with CP, would consequently improve motor function adaptation of ADL that could trigger improvement in other domains of adaptation, ultimately allowing the child to enjoy an enhanced QOL, thus establishing the rehabilitative potential of a newly developed form of PIA which created special conditions with the assistance of the innovative TTC.

The PIA strategy employed two complementary principles: first is the principle of unloading (McAvoy, 2006; Fragala-Pinkham et al., 2009), whereby body weight is 'reduced' (Becker, 1997), by water buoyancy-the Archimedean principle-a process which counters the force of gravity (Campion, 1998b; Salzman, 2009). The second principle is the loading strategy

(Harrison et al., 1992; Dietz and Colombo, 2005), in which the body weight is gradually 'increased' by reducing the degree of immersion (Harrison and Bulstrode, 1987; Miyoshi et al., 2004). Thus, the amount of buoyancy is RCPWB by gradual elevation of the child in the pool at each of a series of upward phases forming new environments at each step for increasingly more challenging adaptation of their functional performance.

The developed PIA integrated three approaches to CP rehabilitation philosophy: The first approach, NDT, uses MP to perform functions in order to facilitate the recovery process (Bobath and Bobath, 1984; Davis, 2001; Howle, 2004). The second approach, CE (Hari and Akos, 1988) was selected because *'the term "adaptation" is being used here in the sense of [the] biological' (p.141)...'concept of adaptation [and translated] into the language of education as concerning social adaptation, [and in this context] then we must speak of "learning"'* (p.146). The third view, is AT partially immersed view, in which the researcher chose to apply an unloading to loading strategy.

The strategy was chosen because the CP condition (Table 4: GMFCS and GMFM criteria) makes it difficult or impossible for children with bilateral spastic CP to experience free independent sitting on land while fully loaded with gravity, without support. This strategy unloading (providing buoyancy support for participants' sitting) toward loading versus the opposite option (loading to unloading) was an innovation of this research (relating to the sitting abilities of participants with the particular type of CP conditions), and the triangulated finding indicate that this strategy produced an obvious positive result.

The PIA applied RCPWB using the TTC in synthesis with the principles and theories of NDT CE and AT approaches.

### 3.3 Challenging Methodology

As mention in Chapter 1 (Introduction), internal validity in the present study is weak; *'hence at best we strive to minimize invalidity and maximize validity'* (Cohen et al., 2000, p.105; Morse and Niehaus, 2009). Therefore, *'If you believe, as we do, that linkage [of different methods] is a good idea, it can lead to overall designs'* (Miles and Huberman, 1994, p.41).

The application of a Mixed-Methods Research (Yin, 2006) or Approach (Creswell and Clarke, 2007), or Design (MMD) (Morse and Chung 2003; Morse, 2006; 2006a; 2006b; 2007a; 2008a) *'enables the incorporation of different types of data, examining a different level of analysis into the study'* (Morse, 2009, p.1524). Morse and Niehaus (2009) emphasise that MMD is systematic. *'It is not a salad!!!' [thus],... 'the more you know about research methods, the easier mixed methods will be!'* (p.154). One option out of many is that the quantitative method should consistute *'the core component [i.e.] measurement or even experimental method design; [while] the*

[qualitative method as a] *supplemental strategy is to provide explanation or to obtain description that the first method cannot access*' (p.31).

### 3.4 The Research Tools and Research Methods

The researcher chose to use a large number of tools, to enhance validity by employing an MMD within multiple case studies with replication logic strategy, including interviews, goniometry, observations and questionnaires. This enabled the researcher to employ what *'have been known as triangulated designs; ...exploring a phenomenon from two or more perspectives [a tactic that] provides more information than one used alone, with the different methods compensating for deficiencies in the other ...[while] one set of findings validates (confirms) the other'* (Morse and Nieaus, 2009, p.10).

### 3.5 The Four Stages of the Research

The duration of the study was 5 years, from the pilot study (April 2002) to the completion of the interview for the last case (January 2007) and comprised four distinct stages. Analysis of the data resulting from each stage of the research was used to benefit and contribute to subsequent stages. All the research stages and multiple case studies generated knowledge, which was then used to improve and test-validate the new PIA.

**Stage 1** of the research was the pilot study relating to *Moshe* (Case 1) investigating the effect of a specially designed TTC, that began with a simple brick lifting strategy developing into the construction of a commercial mechanical rehabilitation tool accompanied by an appropriate PIA-treatment plan.

The pilot study results helped form the criteria for case selection and definition, and were used to establish the inclusion/exclusion criteria for a 'purposive' sample (Cohen et al., 2000), the choice of MMD to be used, to develop tools and strategies for data-collection, and to select the location (pool facility) and evaluation procedures.

*'The pilot case is [useful in many ways]...possibly even providing some conceptual clarification for the research design as well'* (Yin, 2003, p.79), and for *'methodological issues'* (p.80). Thus, the pilot study formed a firm basis on which to develop and construct the subsequent research intervention and study.

**Stage 2** dealt with the design and construction of the TTC in order to provide treatment for children with CP from a new and different perspective. This TTC enabled the creation of new, controlled environments, increasing adaptation to gravity by gradual reduction of bouyancy during Partial Immersion (Harrison and Bulstrode, 1987; Harrison et al., 1992; Salzman, 2009), for the impairment-challenged child.



**Stage 3** involved the production of the research design, focusing on replications (Yin, 2003; Wisker, 2008). Multiple case study should follow a replication rather than a sampling logic (Yin, 1984; 1993). At this stage, the use of Non-Directive Focused Interviews (NDFI) gathered qualitative data that could be used for comparative data analysis (Glaser and Strauss, 1967; Strauss and Corbin, 1998; Corbin, 2009) describing the status of participants' abilities/ family interaction (see Table 8, A1-pre intervention, A3-post intervention test 2 and A4, one year post intervention, below, p.103).

**Stage 4** examined multiple case studies (Yin, 2003; Derthick, 2004; Wisker, 2008) in order to test the effects of the new PIA through duplication thus **Manor** and **Avi**'s cases track differences between water and land environments. Both participants were found suitable to match criteria for the study. **Manor** was a research participant and **Avi** constituted the control for **Manor** in the water part of the intervention (See Table 6). The treatment that **Manor** received: PIA in water (20 sessions of 60 Min each, 4 times per a week) followed by land treatment (82 sessions of 10 Min each, 7 times per a week), while **Avi** only received land interventions, identical to those of Manor. However, both treatment patterns related to the MP of functional aspects during sitting. The issue for this case study was to upgrade the approach of existing AT intervention which has been '*incorporated with a land rehabilitation program [combining both environments] where appropriate for many years, and the practice continues*' (Irion, 1997, p.10). This existing approach makes no attempt to facilitate the bridge between the AT and land environments, although '*exercises in water differ from similar exercises carried out on land*' due to the '*physical properties of the two environments*' (Campion, 1998g, p.177), a task this research aimed to improve.

The treatment for **Maor** emphasising water properties (Appendix 5: Table 1, environmental treatment conditions- water/land- heat difference. Diary: 9<sup>th</sup>,10<sup>th</sup> May, 2005, 6<sup>th</sup>,10<sup>th</sup>, July, 2005), was the first to employ ADLSF, during PIA. The approaches of the Bobaths-NDT and Peto-CE suggest that attaining skills for functional activities is an essential primary goal, which should be incorporated into ADL in the learner's life (Bobath and Bobath, 1984; Maguire and Sutton, 2005). Lately it is '*being recognized that hand function is in fact as important (if not more so) than walking*' (Stanton, 2002, p.56). **Maor** underwent water treatment (Table 6, p. 98), (24 sessions of 60 Min each, 4 times per a week) and land treatment (20 sessions of 60 Min each, 4 times per a week). Total of 44 treatments (Day, Fox, Lowe, Swales and Behrman, 2004).

The treatment plan for **Keshet** emphasised more land properties including PIA treatments that needed to be followed by land therapy in order to achieve better adaptation.

**Keshet's** water treatment (Table 6, p.98) (16 sessions of 60 Min each, 4 times per a week) and land treatment (27 sessions of 60 Min each, 4 times per a week), totalled 43 treatments. The stages, aims and objectives of the study are summarised in the following table, Table 3.

**Table 3: Aims and Objectives of the different Research Stages**

<b>Research Stages and Name of Participants</b>	<b>Objectives</b>
<b>Stage 1 Moshe</b> <b>Aim:</b> To conduct a pilot study	Discovery: what would be optimal conditions regarding time, location, space; methodology; construction of tools for data collection.
<b>Stage 2</b> <b>Aim:</b> To develop and construct the treatment apparatus.	Establishing the theoretical foundations of the chair (developed by synthesis and integration of principles and techniques from different sources) and its contribution to the study adaptation paradigm; interpretative view; principles of the chair's operation; plans to build the TTC (Appendix 2); engineering and constructing the chair.
<b>Stage 3</b> <b>Aim:</b> Forming the Study Design	Definition of and Planning the Case Study; study procedures for data-collection and protocol; data analysis; developing the <i>Rating scale ADL observation test</i> ; determining the study interventions; ethical considerations.
<b>Stage 4 Manor and Avi</b> <b>Aim:</b> Comparing water+land vs. land interventions: effects on sitting	Establishing guidelines for use of the treatment chair; stimulating patients to the limits of their ability to balance/compare between Manor research (r) and Avi control (c)
<b>Maor</b> <b>Aim:</b> To improve skills for ADL functions	Introducing the ADL Skill Function (ADLSF).
<b>Keshet</b> <b>Aim:</b> PIA intervention followed by land treatments	Achieving the meaningful phenomenon of an increase in the participant's free sitting time, from 52 seconds (Table 4) to 8 min. and 30 seconds, at 28 days after the first treatment (Researcher's Notes).

### 3.6 Selection of the Research Methods

*'Are there paradigms after death?....Now....Calm down a bit.....I'm not criticizing your operation down here...I'm just asking....in your entry evaluation process do you operate from a qualitative or quantitative paradigm?' or both? [present author's remark] (Patton, 2002, p.70).*

When a person wants to know the truth of a matter, or wishes to gain knowledge concerning the reality of the world and/or discover specific phenomena, a strategy must be formed, a path of reasoning that must be followed in order to obtain answers. A person's outlook, the way an individual perceives the world constitutes a particular paradigm.

This is defined as follows:

*The net that contains the researcher's epistemological, ontological, and methodological premises may be termed a paradigm, or an interpretive framework, a 'basic set of beliefs that guides action' (Guba, 1990, p.17 in Denzin and Lincoln, 2003, p.33).*

### **3.6.1 Positivistic, Naturalistic and Combined Reasoning**

Each individual can choose to observe and interpret the world from their own perspective; this choice constitutes a paradigm that enables the individual to understand the world. Science has traditionally comprehended the world through one or more of four thinking processes '*deductive reasoning, inductive reasoning, and the combined inductive-deductive*' (Cohen et al., 2000, p.4) and abductive reasoning (Charmaz, 2009).

Cohen et al. (2000) and Patton, (2002) claim that the positivist view is the basis of truth, based on reality, and that the scientific method produces the most ideal knowledge examining the nature of knowledge. Following concepts of the ancient Greeks, positivism was developed in the 19<sup>th</sup> century by the French philosopher, Auguste Comte, claiming that positivism represents a verifiable view of the truth. Positivist research is based directly on positive knowledge of experience, thus enabling researchers to use observation and experimentation to understand phenomena. The search for universal laws through verification, logic and deduced hypotheses enables empirical replication and proof or disproof of phenomena and relationships, employing standards laws and procedures to construct the scientific method. The present research followed positivist philosophy, but the use of this method is insufficient to explore human behaviour (e.g. children with C.P.), which exhibits certain elusive characteristics. Human social phenomena tend to contradict the positivist view of regularity and order of the natural world. This 'order' also has its limitation in the context of the school education system, if one looks at the process of learning, teaching and human interaction, that challenges or limits the positivistic researcher's method. What other option exists? One possibility was indicated by Stern (2009a): '*Well, yeah, Glaser and Strauss were...trying to help positivistic sociologists understand that there was another legitimate way to approach data...[by] interpreting grounded theory for the positivists*' (pp.58-59).

An historical perspective helps to explain the choice of the methodological imperative for the present research, for example the use of 'replication logic' (Yin, 2003, p.48), a deductive

process. Deduction, Aristotle's contribution to formal logic is based on 'syllogism'. Syllogism involves a systematic reasoning process in which *'formal steps of logic, [lead] from the general to the particular, [so that] a valid conclusion can be deduced from a valid premise'* (Cohen et al., 2000, p.4). An opposite point of view from the 1600s, presents a critical view of deductive reasoning. Francis Bacon proposed inductive reasoning, a process which progressed from the particular-specific to the general (Cohen et al., 2000; Lee, 1996 in Patton, 2002). This manner of thinking formed the roots for the Naturalistic view (Patton, 2002; Denzin and Lincoln, 2003). One option may be to employ a Naturalistic case-study that relies on *'inductive reasoning by means of which the study of a number of individual cases would lead to a hypothesis and eventually to a generalization'* (Cohen et al. 2000, p.4). Bacon's inductive reasoning was later developed to become inductive-deductive reasoning that linked both visions-the Aristotelian and the Baconian (Cohen et al., 2000).

### **3.6.2 The Post-positivist View**

The post-positivist view was first articulated by Campbell and Russo (1999, in Patton, 2002; Denzin and Lincoln, 2003). This view partly influenced the present inquiry, so that the following assumptions were applied:

1. A determinist assumption, suggesting that every event has causes and is determined by particular circumstances. The scientific method suggests that this linkage can be understood, and that there is a regularity in the way this linkage is determined; the world is in order not confusion and therefore, world-phenomena can be predicted and controlled (Cohen et al., 2000). Thus, the present inquiry relied on the laws of buoyancy and gravity using an innovative TTC to perform RCPWB and predicted facilitated adaptation for children with CP. This formed the firm basis for the conceptual framework of the research.
2. The second assumption is based on the logic of empiricism (Cohen et al., 2000; Patton, 2002), claiming that knowledge can only be gathered from direct experience. Empirical evidence is needed to support a hypothesis or theory (Cohen et al., 2000). The present inquiry therefore uses several quantitative tools in order to gather empirical evidence to test the effectiveness of the PIA.
3. The third assumption relates to the concept of generalisability, which is used in both deductive and inductive reasoning (Cohen et al., 2000). Fireston (1993) and Shkedi (2005) suggest using analytic generalisation. This viewpoint is reinforced by Yin (2003), who claims that analytical generalisation is more appropriate than statistical

generalisation when conducting case studies, avoiding difficulties for generalisation stemming from small sample size or specific qualities of cases.

Positivist assumptions lead to the basic core question '*What is science*'. Cohen et al. (2000) suggest that this can be answered by saying: '*the ultimate aim of science is theory*' (p.11), but there is more to it, as Lewin (1952, in Trafford, 2002) tells us: '*there is nothing so practical as a good theory*' (p.55).

The aim of the present research was to **test a theory** (PIA) which is defined as: a collection of interrelated concepts held together by a theoretical framework to provide an explanation for and systematic view of the studied phenomena, showing the relationships between variables through the responses to 'how' and 'why' questions (Strauss and Corbin, 1998; Kerlinger, 1970 in Cohen et al., 2000; Shkedi, 2003; Yin, 2003).

### 3.6.3 The Naturalistic View

The naturalistic stance is viewed as: '*softness*' (Yin, 1993; Patton, 2002; Morse, 2006; 2006a), and compared with the '*hard*' (Merriam, 1995, 1998) positivistic view. The naturalistic view focuses on real world settings, even one case (N=1) (Merriam, 1995; Strauss and Corbin, 1998; Patton, 2002; Morse 2006), or a few cases as in the present study.

This theoretical framework of ideas and beliefs relating to ontology and epistemology also determines the relationship that forms between the investigator and the studied phenomenon, the methodology to be used, and the way in which the researcher should gain knowledge from the world (Guba, 1990; Lincoln and Guba, 1985 in Denzin and Lincoln, 2003; Shkedi, 2003; Charmaz, 2009; Clark, 2009). The validity, reliability and generalisation of naturalistic research findings and conclusions are established and judged according to '*terms such as credibility, transferability, dependability, and confirmability*' (Denzin and Lincoln 2003, p.35).

The positivist reasoning employed in the present study is accompanied by thinking processes of Aristotelian-deduction combined with elements of Baconian-induction to form the '*specific paradigms and is therefore relative rather than absolute so...both quantitative and qualitative, are needed to generate and test theory, [and to] improve understanding over time of how the world operates*' (Patton, 2002, p.92).

Therefore, the study was founded on an MMD, defined by Morse, (2009) as '*consisting of one complete project (called the core component), and strategies from a different method used as a supplementary component (conducted simultaneously or sequentially to the core component)*', (p.1523).

## The Debate concerning Method

*I will argue that the long debate over the qualitative/quantitative paradigm issues [involves]... serious concern* (Morse, 2006, p.395).

This inquiry applied a deductive process, 'weaving' to-and-fro through the various relevant theories and principles (Figures 3 and 4) to form the conceptual framework of the research (Figure 1). Data-collection was based on simple case studies, (Table 8, p.103: A1-Baseline pre intervention; A2-Post intervention test 1; A3-Post intervention test 2; A4-One year post intervention). These multiple case studies were formed according to replication logic to enhance validity and developing detailed protocol-appendices, and a rich diary data base that improved processes to establish greater reliability (Yin, 2003; Derthick, 2004). An inductive process used the sequential progress of four RQ as the research imperative, to test the validity of the research hypotheses concerning the effects of the research intervention, on factual, interpretive and conceptual levels of inquiry (Figure 2).

Supplementary qualitative data from NDFI reinforced the validity of the quantitative data (Morse and Niehaus, 2009), providing a thick description of participants' conditions before, during and after the PIA intervention. Additionally, of course, quantitative measurements added to the credibility to the qualitative data. As Morse (2006b) noted: *'There is no doubt that qualitative and quantitative paradigms do things differently'* (p.6), and since both methods have their advantages and disadvantages, it is exactly this difference that can be employed to strengthen the rigour of the research, when both methods are applied to investigate the same phenomenon. According to Yin (2006): *'Mixed methods: relevant combinations go beyond the quantitative-qualitative dichotomy'* (p.41), Shkedi (2003) encourages using both types of reasoning jointly.

## Triangulation

Silverman (1993) in Cohen et al. (2000) explained that: *'Investigator triangulation, refers to the use of more than one observer (or participant) [observation tools] in a research setting'* (p.114), and that researchers could employ *'Time triangulation expanded by Kirk and Miller (1986) to include diachronic reliability-stability [of phenomenon] over time'* (p.113). (The application of replication logic and pre-post-intervention with one-year post-intervention interviews in the present study enabled the researcher to conduct time triangulation). The study employed *'a variety of data sources'* (Denzin, 1978b in Patton, 2002, p.247), within each method so that two data triangulation was also applied, following the assertion of Richardson (2003) that: *'In triangulation, a researcher deploys "different methods"...to "validate" findings'* (p.517), or *'Triangulation between methods...[is] the use of more than one method in the pursuit of a given objective'* (Denzin, 1970 in Cohen et al., 2000 ,p.114). Morse (2006b) notes that using: *'different types of data - and with*

*different methods - there are different means of determining rigor* (p.6), yet she also indicates (Morse, 2008a) that the researcher should *'give equal weight to both'* (p.1608).

#### 3.6.4 The Choice of a Suitable Method

Morse and Niehaus (2009) suggest that a researcher employing an MMD should use a primary core component as the theoretical drive for a single study and combine it with supplemental strategies belonging to another or same method. An MMD study therefore needs both components (core and supplemental) to establish sufficient rigor to justify publication, so that in MMD none of the decomposed component methods have sufficient rigor to stand by themselves as a complete study. In contrast, Multiple Method maintains isolated procedures for each method (Yin, 2006). Each component has sufficient rigour to stand alone as a complete valid study. However, both component-methods are used to address the same RQ, goal, and the programme's aim, although the researcher will *'use two complete [different] methods'* (Yin, 2006; Morse, 2009, p.1523).

For work with a small sample, Morse (2006) relates to a *'deliberate trial or testing of interventions with N=1 research'* (p.402), suggesting that this method, which is usually used for experimental trials demanding qualitative microanalysis. This can be combined with repeated quantitative measuring designs. This method has potential for health care research when studying rare events such as heart transplantation, while Piaget also used it in his naturalistic experiments, when he observed his infants to develop his theory, a theory which is confirmed when his conclusions are observed to be true in the behaviour of millions of other infants, which replicates his findings (Cohen et al., 2000; Morse, 2006; 2008). But, in the opinion of Morse (2006) *'case study design is an inadequate description of this type of research'* (p.402). Since the researcher decided early on in the process, to test theory and not to generate-develop theory, case study where n=1 was ruled out.

Other options that the researcher considered included *'forensic designs'* (p.401), that are used to study traumatic incidents or disaster with an aim for prevention; *'Observation and precise, microanalytic observational description ... is classic qualitative inquiry'*. This was deemed inappropriate in the present study since the study *'core'* was based on the quantitative method. It might also have been possible to employ a *'simulation'* method that focused on *'"crash test dummy" type of research'* (p.402). This type of research, also aims to reduce risks involved in experimentation. Since these methods deal with prevention and risk reduction they focus on one or more events but follow inductive thinking to generalise their conclusions, while the core method of the present study used deduction and merely added inductive thinking to increase its validity.

Morse and Niehaus (2009) suggest that if Grounded Theory is selected as a study's core in MMD, it should be employed as the primary method rather than as a supplemental component. However in the present study an opposite strategy is used, the core is a quantitative component and the qualitative data-collection and analysis were used to supplement and reinforce the quantitative data. *Grounded theory would strongly discourage a theory-testing posture ... Grounded theory is therefore eminently interested in theory-building and not theory-testing*' (Yin, 1993, p.67 and p.61, see also Glaser and Strauss, 1967). For these reasons Grounded Theory was considered inappropriate for the current study.

The researcher therefore employed an MMD using a quantitative core and a supplemental qualitative part while adding a '*question* -[No.4 in this study][that] *would greatly improve the research. An emergent design, therefore, is a sequential design that was not planned* [and is] *added after the core component [is] completed*' (Patton, 2002; Morse and Niehaus 2009, p.17). The validity and reliability of the MMD was fortified by using replication logic and developing the appendices-protocol and diary-data base, in a multiple case study strategy (Yin, 2003) to test the effects of the experimental PIA.

To summarise: this section explained the theoretical foundations of the research methodology and explained the research stages that formed the research design. The research framework, internal paradigms and methods are now described.

### **3.7 The Research Framework**

The 'case study' described by Yin (1984); Stake (1995); Strauss and Corbin (1998); Stake (2000); Cohen et al. (2000); and Wisker (2008) is a research strategy which investigates a topic using specific empirical procedures. As its name implies, it focuses on one unique phenomenon, or issue; in the present research the case study focused on four cases of children with CP undergoing a process of sitting-adaptation in AT and land environments.

#### **3.7.1 The selection of Case Study as opposed to Action Research or a Quasi-Experimental or Ethnographic Research**

From the start, the researcher knew that it would be impossible to find many suitable candidates for the research due to the strict inclusion/exclusion criteria and the rarity of the studied phenomenon. The researcher decided on a case study rather than action research, following a cyclical process of planning, acting, observing and reflecting (Kemmis and McTaggart, 1992; Kemmis and McTaggart, 2000) although, the research intervention was not conducted as a cyclical process and did not focus entirely on actions. Rather, its aim was to test the quantitative effects of systematic use of PIA through multiple case studies formed according to replication logic. The findings of such a study could be employed for



analytic generalisation (Glaser and Strauss, 1967; Fireston, 1993; Yin, 2003; 2004; Shkedi, 2005).

Choosing to use the case study strategy was also justified from another perspective: a case study enables the researcher to conduct quasi-experimental research (Kemmis and McTaggart, 2000). According to this perspective the researcher focuses primarily on designs, sampling, and comparisons based on outcomes of interpretation (Yin, 1993). The present study predicted a linkage between AT that employed RCPWB to alter buoyancy to facilitate motor function adaptation and improvement in the participants' QOL. Since there were clear limitations on the number of suitable candidates for the research sample, it was considered more appropriate to choose multiple case studies over quasi-experimental research, enabling the researcher to follow a replication logic: *'a series of case studies ...to examine these linkage situations and how these outcomes were produced'* (Yin, 1993, p.9).

Morse (2007) and Cohen et al. (2000), justified the use of different types of *'non-probability samples [for] case study research [which does] not intend to generalize ... findings beyond the sample in question'* (p.102). This sampling method is employed in small scale research aimed at a specific group of participants, such as the children with bilateral spastic CP in the present study, although they can not represent a wider universe because they have unknown chances to be selected from that wider universe; while in the case of probability sampling *'the chances of members of the wider population being selected for the sample are known'* (Cohen et al.,2000, p.99). The rationale for non-probability samples differs from the rationale for larger designs and sampling logic.

The researcher also chose purposive sampling where the *'researchers handpick the cases to be included in the sample on the basis of their judgment of their typicality'* [and build a sample to suit] *'their specific needs'* (p.103). Such a sample is used when the researcher specifically intends to choose *'critical cases'* or *'critical events'* (p.103): in the present study children with CP who exhibited difficulties in performing free-independent sitting ability. The complexity of purposive sampling means that it is deliberately used for the investigation of a particular type of phenomenon and is therefore biased. It is therefore necessary to be careful to qualify findings appropriately. Purposive sampling results are considered less definitive and usually require replication in a more controlled setting. It is also only possible to qualify results by extrapolating them to a much more targeted and narrowly defined universe.

The researcher also decided not to employ ethnographic research (Cohen et al., 2000), because ethnographic research produces a '*thick description*' of details from the real world, capturing the essence of everyday human life, over long periods of time of data collection, using observation which involves the understanding and presentation of multiple subjective realities that are socially constructed rather than a single objective reality. Ethnographic study therefore rejects the scientific empirical reasoning of repeated replication which would make its evidence relative (Guba and Lincoln, 1982; Fetterman, 1989; Yin, 1993). Ethnographic research was therefore considered unsuitable for a study of the particular phenomenon observed in the present research, the adaptation of children with CP to their physical environment.

The present study applies an opposite view, it aims to create replication (Morse, 2008) which means that two or more cases should be included in the study, precisely because the researcher predicts that similar results (replications) will be found. If indeed such replications can be found (see with regard to CP: Barnes, 1989), greater confidence is provided for the overall results. '*The development of consistent findings, over multiple cases and even multiple studies, can then be considered a very robust finding...The more replications, the more robust your findings will be*' (Yin, 1993, p.34). The variegated mix of methods further strengthened the study's authenticity, as Yin (2006) noted '*using mixed methods...can simultaneously broaden and strengthen the study*' (p.41).

### **3.7.2 Criticism of the Case Study Strategy**

Yin (1984; 1993; 2003) notes scholarly criticism concerning case study approach: it has been labelled as weak in terms of objectivity, insufficiently precise or rigorous, too subjective a way of collecting data, and unable to produce constructive validity. Critics focus on the problem of external validity and the fact that the direction of the RQ can alter as the study shifts from its original design, creating gaps and biases, difficulties involved in creating a data base, less controlled documentation and sometimes a tendency to form overly conclusive interpretations, which lead to subjectivity (House, 1982 in Yin, 1993).

The question is therefore pertinent: why would investigators continue using it? (Yin, 2003). First, they may not have alternatives and second, case study is useful for examining holistic, meaningful characteristics of real-life events such as organisational processes, international relations or industrial development. Case study is used for contemporary events, adding direct observation to systematic interviews and can use many sources of evidence, such as observation, artefacts, interviews and documents, to understand and validate the phenomenon being studied, by employing interpretation of 'how' and 'why' questions.

Case study also has the advantage of being flexible, in that (as also in action research) the list of questions can change and issues can be redefined, which may in turn modify the aim of the inquiry. The resultant data collection can be adapted to different types of evidence, and can, without bias, combine quantitative and qualitative data, or compare these data. The outcome of the interpretation of these two types of data can serve to test or generate a theory, and provide material for triangulation to reinforce the validity of the case study (Glaser and Strauss, 1967; Stake, 1995, 2000; Yin, 1984, 1993, 2003).

The case study can be intrinsic, instrumental or collective, or it can be explanatory, enriched by exploratory and descriptive data; it can be holistic versus embedded, and can take on either single or multiple designs.

The present case study is defined as 'explanatory' (testing theory: the specially developed PIA and its application to rehabilitation practice) (Yin, 1984). Yin (1993) and Cohen et al. (2000) describe the 'explanatory case study' as one that uses data to examine cause-and-effect relationships. The sequence of RQ guiding the present study applied this principle progressing from 1-4 according (Figure 2), cause-and-effect relationships occurring in real-life contexts.

### **3.8 The Research Paradigm**

The research applied an adaptation paradigm employing the premise indicated by NDT and CE regarding '*biological adaptation*' (Hari and Akos, 1988, p.15 - Figure 1), indicating that if the organism is having trouble adapting, then the environment needs to be manipulated so that adaptation can take place. The researcher therefore employed a specially invented TTC tool in a PIA intervention, to manipulate environmental conditions.

#### **3.8.1 The Interpretative Paradigm**

Strauss and Corbin (1998) describe a paradigm as a tool used to organise data into an integrated structure and process. The interpretative paradigm supports the belief that reality is constructed by subjective perception and predictions cannot be made. Human beings cannot be studied using models developed for the physical sciences because humans are qualitatively different from natural events. Researchers who agree with this paradigm are interested in the social construction of meaning. People have free will, purposes, goals, and intentions, so people should be studied as active agents. Cohen et al. (2000) note that '*all theories constructed within the context of the interpretive paradigm tend to be anti-positivist*' (p.22). The researcher's objective was to delve into the sitting phenomenon of children with CP and understand it from within, to understand the interpretation of the world by the children,

their families and school staff, extrapolating meaning from the singular case to plural cases. This naturalistic induction process was supplemented by positivist inquiry since:

*If one studies structure only, then one learns why but not how certain events occur. If one studies process only, then one understands how persons act/interact but not why. One must study both structure and process to capture the dynamic and evolving nature of events* (Strauss and Corbin, 1998, p.127; Yin, 1984; 1993; 2003).

### **3.9 The Investigative Process: Generating, and validating Theory, the Theory of PIA**

The above-mentioned supplemental qualitative component of the research employed an inductive approach to analyse the data. *'Qualitative data are sexy. They are a source of well-grounded, rich descriptions and explanations of processes'* (Miles and Huberman, 1994, p.1). However the theoretical drive, the core method of this study uses another type of thinking. This is deductive reasoning, based on syllogism, Aristotle's contribution to formal logic. This logical reasoning process assumes that a valid conclusion is based on a deduced valid premise (Cohen et al., 2000). Glaser and Strauss (1967), Anastas and MacDonald (1994), Strauss and Corbin (1998), and Yin (1984; 1993; 2003), all advocate validation through 'replication logic', claiming that consistency of findings over multiple case studies produces robust and validated findings.

The present research brings together both thinking processes to generate, test and validate theory based on consistency of replication of the findings, using qualitative data from NDFI for comparative analysis with quantitative data. As noted, multiple research tools are used as part of the MMD, and this variety of tools from different fields produces quantitative 'core' data, which present numbers and percentages derived from pictures, video film, and goniometric measurements and also supplementary descriptive data based on verbal interviews (including interviews conducted one-year post-intervention).

These varied data sources enabled the researcher to conduct 'between methods', 'time', 'investigator' and two-data triangulations (Denzin, 1970 in Cohen et al., 2000; Patton, 1987; 2002), to enhance the validity of the data and inquiry.

Since the sample was very small and part of the data was qualitative data, generalisation was *'characterized as analytic generalization'* as opposed to *'statistical generalization'* (Firestone, 1993; Yin, 2003, p.10), providing a potential for the generalisation of these findings to other theory (Yin, 1984; 1993; Firestone, 1993; Yin, 2003; Shkedi, 2003; 2005). This is *'analogous to the way a scientist generalises from experimental results to theory'* (Yin, 2003, p.38).

The study took place in a real world, testing the PIA in what was sometimes an unpleasant environment, when the pool was very crowded. It examined processes during real time.

The analysis of the data was built segment by segment, in response to evidence collected in the field through the different tools, and triangulation of this evidence. It was constructed according to an inner logic during each case study and across the cases. In between cases certain phenomena were questioned, analysed, and conclusions were reflected back to the next case, or compared to similar phenomena from previous cases.

### **3.9.1 The Sample Research Population: The Study's Universe**

The present study's universe consists of 250 children with CP within the jurisdiction of the JBED, from nursery to school Year 12 (Diary: 24<sup>th</sup> March, 2005).

A small purposeful sample (Mason, 1996, Morse, 2007) of five participants - 2% of the above-mentioned source population (in four case studies) were selected for the present study according to the selection criteria and research procedures. All five participants attended three schools selected for the study, supervised by the JBED and operating according to its authorised guide-lines.

The study used a multiple cases study strategy, not for sampling purposes or to deduce universal generalisation, but rather aiming to utilise a replication logic to obtain consistent, robust findings (Yin, 1984; 1993; Strauss and Corbin, 1998; Cohen et al., 2000). This replication logic was found suitable to be applied to the specific type of population: children with CP, and to the situation and selection criteria represented by the research participants. Quantitative replication logic was therefore the optimal choice of method as only minimal external validity could be established for generalisation.

All five participants (detailed in Table 4), had been diagnosed by a neurologist as having bilateral spastic CP (Cans et al., 2007)- GMFCS test rating level IV (Palisano et al., 1997, see description of GMFCS in section 3.12.4). All participants were chosen from 'normative' families in the Jerusalem area, living with their families in an Israeli-Jewish culture, except for Avi, who lived in a government institution in Jerusalem and saw his family regularly on a weekly basis. All participants were able to communicate but needed the use of a wheelchair for mobility with the provision of special transportation to arrive at the intervention site. The five participants needed assistance in ADL activities including upper extremities skills with HHC, e.g. eating. They were chosen because they all complied with the Inclusion/Exclusion criteria detailed below, (other candidates did not comply and were excluded). All parents signed an agreement and a letter of informed consent (see Appendix 11). All participants expressed their desire to improve their sitting.

Participants were initially able to sit on a stool with assistance or supported by a person's hand. **Manor**, **Avi**, and **Maor** were pre-intervention able to sit independently in a crouched position, bent forward, supported by their hands and elbows on their knees, head faced downwards towards the floor. Before the intervention, **Moshe** and **Keshet** lost sitting balance in less than one minute.

Initially, none of the participants was able to sit independently and to reach forwards. None of them could sit with erect body and head posture with hands free for manipulation for more than 3 minutes. None of them could stand or walk independently. All underwent body measurements (see Diary 12<sup>th</sup> September, 2005) and two functional evaluations (blinded with regard to the interventions) by a Physical Therapist.

Table 4 below provides the initial data concerning the participants' characteristics.

**Table 4:**  
**Body Measurements and Characteristics, including Participants' Abilities**

Child's Name	Free Sitting Time (min.sec)	Total Distance of Immersion (mm)	Age (yr.month)	Weight (kg)	Height (mm)	Arm Span (mm)	GMFCS Level (IV-4)	GMFM Score (%)
Moshe (p)	0.40	300	15.4	41.12	1315	1280	IV	00.00
Manor (r)	10.30	267	11.1	17.30	1225	1240	IV	34.40
Avi (c)	10.01	250	11.00	19.70	1277	1034	IV	24.70
Maore	10.00	297	10.00	20.13	1220	1275	IV	28.84
Keshet	0.52	312	11.11	40.20	1266	1101	IV	19.24

KEY TO TABLE 4

c	Control participant	GMFM	Gross Motor Function Measure Manual (Russell et al., 1993)	r	Research participant
GMFCS	Gross Motor Function Classification System (Palisano et al., 1997)	p	Pilot study	IV	Palisano et al. (1997)

### **3.9.2 Inclusion and Selection Criteria (Drummond, 1994 in Shelef, 1998).**

1. Diagnosis of CP by a neurologist.
2. Ages between 10 years, 0 months and 11 years, 11 months, since limiting the age range is an important factor (Harris, 1969; Law et al., 1991; Winnick and Short, 1991).
3. Physiological classification: 'Spastic CP subtypes' (Cans et al., 2007, p.37).
4. Topographical classification: bilateral CP (Cans et al., 2007).
5. Independent sitting ability on a stool in erect posture for a maximum of 3 min.
6. GMFCS level IV-4 self mobility limitation person needs transportation using power for mobility in/out of doors and also in the community, the scale is based on 5 ordinal levels (Palisano et al., 1997).
7. GMFM total score between 19% and 34%, testing take place without: socks, shoes, orthoses or aids (Russell et al., 1993).
8. Capacity to communicate, understand and respond to simple instructions, such as the ability to relax and respond to the environment and to the research staff.
9. A history of regular school attendance.
10. A cognitive function from normal to moderate retardation (as classified by Placement Committee-Appendix 9).
11. No fixed deformities of shoulders, hips or lumbar joints.
12. Ability to flex, extend and rotate head.
13. Existence of some type of documentation relating to the child's sitting development from infancy toward childhood.

### **3.9.3 Exclusion Criteria (Drummond, 1994, in Shelef, 1998).**

Children without CP diagnosis, above or below the age range, or children with CP with fixed shoulder, hip or lumbar joints deformities were excluded from the study. Other types of physiological and/or topographical classifications that were precluded were candidates with a physical or mental capacity that prevented them from coping with treatment or with evaluation through testing.

Candidates with cognitive abilities below moderate retardation abilities could not be included, due to communication and functioning disabilities, nor could those unable to meet any of the inclusion criteria (See Researcher's Diary: 28<sup>th</sup> October, 2003, 27<sup>th</sup> March, 2004, 20<sup>th</sup> April, 2004, 1<sup>st</sup> August, 2004, 11<sup>th</sup> and 25<sup>th</sup> August, 2005).

### 3.9.4 Case Selection

*'Selecting the case or cases to be studied is one of the most difficult steps in case study research'* (Yin, 1993, p.8). Yin (1989); Patton (1990) and Vaughan (1992) in Stake (2000, p.446) all explained that *'understanding the critical phenomena depends on choosing the case well'*.

Certain problematic issues are involved in selecting the proper cases. Selection was performed in the present research on the basis of telephone conversations and informal conversational face-to-face interviews.

Aspects of the research field reality presented major problems such as: access to pools, regulating water temperature, logistics of transportation and time coordination, availability of volunteers and finances.

Five factors determined the solutions for these issues:

1. Selection criterion focused only on the Jerusalem area, where the researcher was able to control most of the above-mentioned issues.
2. Access to a pool was available in the chosen school.
3. The researcher's good relationships with the school staff facilitated access to information on the participants and therapy.
4. The researcher's previous employment and acquaintance with the school principal helped the researcher identify suitable cases, meet the parents, and obtain the necessary consent of the JBED and the parents of the studied children (Researcher's Diary: 28<sup>th</sup> August, 2002; Appendix 10, Diary: 8<sup>th</sup>, 10<sup>th</sup>, June, 2003 and Appendix 11).

These factors helped the researcher in designing the treatment plans, transportation, regulation and procedures.

5. The researcher's prior acquaintance with children with CP facilitated the selection of the cases, connections with the parents, planning the case studies including the amount and type of intervention, and also provided improved conceptualisation of the process of the entire multiple case study.

To further verify whether candidates met the selection criteria, additional input information (e.g. Doctors, psychologist, social work, teachers, therapists and committees reports), was gathered from pre-school and school records, plus input from the principal and other staff members and parents.



### 3.10 The Research Method

The present study involves a multiple case study (Yin, 2003; 2004; Wisker, 2008), because a *'collective case study, an early commitment to common topics, facilitates later cross-site [case] analysis'* (Stake, 1995, p.25). Also, it is able to *'increase the likelihood of generalisability'* (Wisker, 2008, p.217). Although a small sample (5 participants) was involved, the multiple case study in an MMD (e.g. combining observation tools 4,5 and 6 in Table 5 below, validated by 'investigator' triangulation) produced relatively high validity. This strategy enabled the researcher to *'clarify meaning by identifying different ways the phenomenon is being seen'* (Silverman, 1993 and Flick, 1998, in Stake, 2000, p.444), while also *'verifying the repeatability of an observation or interpretation'* (Stake, 2000, p.443). The tools used in the present research are detailed in Table 5 below. Each tool is introduced as described in the literature and in terms of its purpose in this study, its advantages and disadvantages, and contribution to the study in the context of the studied phenomena. Strauss and Corbin (1998) indicated that *'tools and procedures have no relevance without an understanding of the purpose for which they were designed'* (p.99).

**Table 5: The Research Tools-Methods**

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
1. Informal Conversational Interview -the tool is defined as ' <i>questions [that] emerge from the immediate context and are asked in the natural course of things</i> ' Patton (1980) in Cohen et al. (2000, p.271).The researcher used 36 such interviews, which are recorded partly in Diary data base and partly in personal Diary-Hebrew.	Method chosen because it addresses problems of study design, case study selection, setup of the pilot study, total study framework, treatment chair design and because the researcher needed immediate feedback for his problem in determining the field of focus.	It gives feedback in the context of the process itself: no need to arrange questions, etc. in advance.Increases relevance of question, used under any circumstance or with any individual.	Can not be generalised or repeated by other individuals. Is not systematic. Analysis is difficult because it is specific to a particular issue. It was only used in the study before the intervention.	The method contributed knowledge concerning the following elements: The type of CP participants for the study, the amount and types of treatment, the strategy of constructing the treatment chair, and the advantages and disadvantages of this strategy.
2. Non-Directive Focused Interview (NDFI). The tool is defined as ' <i>seeking to follow closely the principle of non –direction, the method did introduce rather more interviewer control in the kinds of questions used and sought also to limit the discussion to certain parts of the respondent's experience</i> ' (Merton and Kendall 1946 in Cohen et al., 2000,	Method chosen because the researcher needed to know why, what and how the participants' motor sitting adaptation skills improved and how these changes influenced competence, psychosocial domains and the child's QOL. NDFI qualitative data adds major additional perspective to balance out and triangulate with quantitative data.	The client can explain the problem in his own words, the client's situation is respected, and no topics are restricted. It focuses on the type of data and the hypotheses that the investigator wants to obtain during the interview. It gives the investigator the ability to test the validity of the data and developed hypotheses.	It limits the interview to the particular situation concentrating on. Using questions that are focused on a particular field or interest. Limits the researcher to relating the interview to a particular individual's needs (Cohen et al., 2000). It might also be dependents on the psychological state of the child at present time of	To help the interviewee see if any change has occurred before and after intervention. This tool balances out the complete picture, when combined with the quantification tools that produce numerical data. (See Appendix 12: Qualitative Interview Questionnaire).

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
p.290). The researcher used 44 NDFI with participants, parents and staff in pre-post intervention format. Quotations from NDFI appear in Chapter 4: Findings.			interview.	
3. Universal Goniometer The tool is defined in the ' <i>clinical environment, the most common device for measuring joint angles or [range of motion] ROM</i> ' (Clarkson, 2000, p.11).(See Appendices ,13,14, Goniometry).	Method chosen because it added a different perspective on reach sitting evaluation. It links between measurement of hip flexion during reach sittings with trunk flexion forward (femur stationary) using equilibrium process (the ability to return to balance sitting orientation), extending trunk without help. Hip joint chosen because flexion and exstention of trunk mostly enabled by the hip. Universal Goniometer offers different modes of operation that measure specific joints in the body and is simple, easy, economical and very safe.	As the name implies, it is universal. The researcher evaluated children of different sizes, and thus needed a tool that could be size-adapted. It is simple, easy, economical and very safe. It has been shown to be very reliable (Boone et al., 1978; Riddle, Tothstein and Lamb, 1987; Clarkson, 2000). A single person can operate it.	The results are based on a mean of three readings, thus it does not provide exact measurements. Its operation is based on having pre-post tests and identical axial-point landmarks on the body, which may reduce the validity of the results. Also, the tool is based in passive form, on the assisted manipulation of limbs, which affects measurement validity.	According to Reid's (1997) definition, if one measures the active ROM of trunk flexion at the hip joint during sitting, a greater ROM should indicate better sitting balance (Cotton and Parnwell, 1967). The ' <i>body orientation relative to gravity played as great or greater a role in controlling muscle hyperactivity as the angle of hip flexion</i> ' (Nwaobi et al., 1983; Nwaobi, 1986, 1987 in Myhr and von Wendt, 1991, p. 247).

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
4. Rating scales observation of the Sitting Assessment for Children with Neuromotor Dysfunction (SACND) (Reid, 1997). The tool is defined as a ' <i>method [in which] the researcher is asked to make some judgment about the event being observed, and to enter responses onto a rating scale</i> ' (Cohen et al., 2000, p.309). (See Appendices 14-SACND; 15).	Method chosen because it evaluates static and dynamic sitting skills reflected in the participant's abilities to sit at rest and during reaching. No other quantitative tool can provide this. Complies with NDT, and CE recommendations for independent sitting on flat horizontal stool base, with the hip, knee and ankle joints being as close as possible to a 90° angle influencing design of the intervention's TTC.	Clinically, the tool is the simplest, most economical method, requiring few resources. Tool adopts a free sitting position on a flat stool, based on NDT and CE approaches claiming that movement is guided and controlled by the child with CP (Cotton, 1965; Bobath and Bobath, 1984), rather than on manipulations of the seat-base's inclination (Mandal, 1976; Nwaobi et al., 1983; Bendix, 1984; McPherson et al., 1991).	SACND requires more than one person to evaluate the CP participant. Aims to produce quantifiable numerical data. Only children who can sit for at least 5 minutes. can be evaluated. It has some limitations on the participant's security during sitting. The tool lacks sensitivity to minor changes in sitting performance.	The SACND involves a method, and is valid and reliable. All other tools serve to improve the basic 'picture' yielded by the SACND test. It was the main study tool because it provides both aspects of sitting performance, i.e. at rest and reach sitting, which no other quantitative tool can provide.
5. Interval Recording Observation (IRO) The tool is defined as follows: ' <i>This method charts the chronology of events to some extent...requires the data to be entered in the appropriate category at fixed intervals...so, for example, if recording were to take place every thirty seconds...Whilst this</i>	Method chosen because it captures images of the rest sitting position by generating data in photographed pictures, which were used to illustrate the best trunk and head position relative- (compared) to the line of vertical gravity (Myhr and von Wendt, 1991; McClenaghan et al., 1992), i.e. 90° to the floor.	The tool is sensitive to changes in sitting performance, and it is very simple to operate, at little expense. One can qualitatively evaluate the endurance aspect of the sitting process during the 7 minutes required for the photographic recording. The digital and video cameras produce a quantitative	The tool could only be used to evaluate children who could sit a minimum of 5 minutes without assistance. Sitting on a stool alone carries the hazard of falling. The researcher has to accurately map the location of the equipment making up the tool, as well as their distances and heights, in	Produces numerical data and focuses only on the basic, at rest sitting performance, in contrast to the reaching module in the SACND test. It also generates qualitative pictorial data, which are used to show families and other staff members, children with CP and their parents

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
<i>enables frequencies to be calculated, simple patterns to be observed and an approximate sequence of events to be noted'</i> (Cohen et al., 2000, p.309, See Appendices: 15,17,18.	Evaluates participants' intervention on posture which effect , stability and balance. Photographs were taken from the side view to investigate the effect of MP, which was chosen as a treatment strategy for present study. This choice relied on the emphasis of Bax (1964) on MP; and the definition of CP by Rosenbaum et al. (2007a).	analysis using qualitative change of movement performance, thereby creating a tool that can effectively assess the CP sitting skill (Harris and Heriza, 1987; Kluzik, Fetters and Coryell 1990).	order to be able to duplicate the process using replications logic in multiple case studies (Myhr and von Wendt, 1991; Yin, 1984; 1993, 2003). Two people are required to operate the tool. The digital camera misses information between the recording intervals of 30 seconds. Intervals are suited to amount of random data points for comparison and for camara reload. If faster,might not produce benefits.	(with permission): this helped attract more participants to the study and generate funding from donors.
6. Rating Scale ADL, Observation Test (RSADLOT) during free sitting. The tool is defined as follows: ' <i>Observed ...behaviour might be entered onto rating scales by placing the observed behaviour onto a continuum'</i> (Wragg (1994) in Cohen et al., 2000, p.309), (See Appendix 16).	Method chosen because it tracks the status of reach-active sitting qualities on a stool during practice of ADL functions of, with a focus on hand-to-head coordination which to the best of the researcher's knowledge no other tool mentioned in the literature at the time of the research could do.	It evaluates free sitting performance in the context of ADL, which no other tool in the literature can do. It is made for the CP condition. It is sensitive to detection of improvments. It has abilities to evaluate both and differences between hands. It is designed to evaluate skills introduced by	It lacks validity and reliability. The size of the sample cannot provide such information. The tool provides numerical data and percentages, but no explanations for the observations (Strauss and Corbin, 1998). Rating scales suffer from subjective interpretation: what is, for one observer, 'good', is 'very good' for	It produces clinical data which indicate, numerically, the status of active sitting during ADL function. This is the most relevant information in determining the type and quality of the intervention. To enhance the validity of the tool, its results can be compared to other tools ' <i>to increase</i>

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
		<p>progressively increasing the leverage of the reach away from the line of gravity.</p> <p>It was developed to reach over the center line of the body. It develops the independent sitting of the child with CP.</p> <p>It indicates where in the progression the participant is, relative to time.</p>	<p>another. It produces responses with greater subtleties than the observed data (Cohen et al., 2000).</p>	<p><i>construct validity...the first is the use of multiple sources of evidence, in a manner encouraging convergent lines of inquiry, and this tactic is relevant during data collection'</i> (Yin, 2003, p.36).</p>
<p>7. Rating scales questionnaire using the Gross Motor Function Measure Manual (GMFM) (Russell et al., 1993). The tool is defined as '<i>One way in which degrees of response, intensity of response, and the move away from dichotomous questions'</i> (Cohen et al. (2000, p.253).</p>	<p>Method chosen because it tracks the status of the participant's general function and indicates whether the intervention variable is affecting the general status of the child's function relative to a particular dimension.</p>	<p>First, it highlights the sitting dimension. Second, the participant aims toward a goal according to dimension and summary of the goal's total score. Third, it enables the evaluation of participants with aids or orthotics, or in wheelchairs, which other testing tools do not provide.</p>	<p>To generate numerical data without providing an indication of the 'how', 'why' or 'where' questions. The tool is designed for use with large samples; in the present study, I used a series of case studies, limiting our ability to make generalisations.</p>	<p>It generates a function abilities profile of the child before and after intervention. Enables construction of case study inclusion criteria by defining the participant's functional limits. Sitting data can be compared to other tools.</p>

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
8. Rank ordering questionnaire using the Gross Motor Function Classification System (GMFCS) (Palisano et al., 1997). The tool defined as <i>'The rank order question is akin to the multiple choice question in that it identifies options from which respondents can choose'... 'to identify priorities'</i> (Cohen et al., 2000, p.252).	Method chosen because it classifies the gross motor functions abilities of the participants and provides information that assists formation of inclusion/exclusion criteria for selection of appropriate cases for the sample and was therefore only used in the study before intervention.	First, it highlights the abilities of gross motor function of each participant. Second, it created equality between the cases. Third, it aims at selection, which case is in the study and which case is out. Fourth, the clinical method of evaluations is very simple and easy to use-not exceeding 10 minutes (Palisano et al., 1997).	It generates numerical data without providing any quality of movement. It limits our ability to make generalisations. Generalisations can only be very limited and specific to the level of criteria. It is intended for use with children with CP of age 12 maximum. (Palisano et al., 1997).	It creates homogeneity between the cases. Indicates gross motor function relating to time, space and conditions. Defines gross motor limitation, providing wide angle of tools for inclusion criteria. The tool is specific for CP participants.
9. Rating scales questionnaire using the Pictorial Scale of Perceived Competence in Israeli Children with CP (PSPCICCP) (Schneider, 1996). The toll is defined as one that <i>'provides a range of responses to a given question of statement'</i> (Cohen et al., 2000, p.253, See Appendix 19).	Method chosen because it generates quantitative-numerical data, which indicates whether changes in motor-function adaptation abilities, performance and independence of the child with CP during sitting intervention have any effect on the child's perceived competence (Vermeer, 1992; Hutzler at al., 1998; Curdova et al., 2001). To the best of the researcher's	It provides the format and steps involved in administering the test in accord with the abilities of the child with CP. Two cognitive stimulations are tested (observing and hearing), working in the same direction, dividing the answering process into two parts, based on a strategy of elimination. Other tools do not provide such a CP-adapted format. The tool	It has 57 items, which may be too many in terms of concentration for some children with CP to handle. Not every child will interpret the test pictures in the same way. To solve this issue a pre pilot test can be used to ensure that the children will interpret the picture in the same manner.	Lies in the context of the phenomena that it aims to evaluate: the achievement of motor skill and task, increasing <i>'perceived competence'</i> (Harter, 1982), which then affects not only the motor field but also the social field (Vermeer, 1991 in Vermeer, 1992).

Name and Origin	Why was it chosen? The Aim	Method's Advantages	Method's Disadvantages	Method's Contribution
	knowledge this questionnaire included questions which were most suitably phrased for the Israeli children's culture and it is written in the Hebrew language.	versions are mixed to increase the validity of the results.		



### 3.11 Collection of Research Evidence, Testing and analysis

The major multi-faceted concepts used to determine data verification are validity and reliability (Morse, 2006b). Cohen et al. (2000) argued that *'It is unwise to think that threats to validity and reliability can ever be erased completely; rather, the effects of these threats can be attenuated by attention to validity and reliability throughout a piece of research'* (p.105). Further, *'reliability is essentially a synonym for consistency and replicability [included repeatability] over time, over instruments and over groups of respondents'* (p.117) as done in the present research.

To minimise these 'threats' to validity and reliability, it is important to follow three principles suggested by Yin (1984, p.78, see also Yin, 2003, pp.97-106) for data-collection in case studies: *'(1) multiple sources of evidence ... (2) a case study data base ... and (3) a chain of evidence'*. Strauss and Corbin (1998, p.196) called the latter concept a *'chain of events'* where the researcher *'might attempt to examine the nature of association among conditions to each other, to action, and to consequences'*.

The use of multiple sources of evidence and maintenance of a chain of evidence both increase the study's internal and construct validity (Merriam, 1995, 1998; Cohen et al., 2000; Yin, 1984, 2003, See paragraph 3.19.2 Improving Validity). Quantitative and qualitative data were collected according to four *'units of data collection'* (Yin 2003, pp.75-76), or at four data points (Thorpe et al., 2005). Following the precept proposed by Yin (2003, p.15) that *'case studies can be based on any mix of quantitative and qualitative evidence'*.

The different therapeutic interventions ran according to schedules, using the research tools along and between the evaluations to collect quantitative and qualitative data collection (see Appendix: 20).

#### **Research Intervention of A/B/A/C/A/D/A**

The formula of **'A/B/A/C/A/D/A'** was used (Anastas and MacDonald, 1994, p.204). (Note: D/A- was not used at the present stage, only at the one year post-intervention follow up).

#### A1 Baseline pre-Intervention (See Table 8)

Data-collection A1 produced quantitative and qualitative data, focusing on participants' sitting and body measurements (Diary: 12<sup>th</sup> September, 2005 and Table 4), using GMFM, and GMFC (Table 5: Number 7 and 8), constituting indices for general abilities and function. At this stage, the researcher evaluated sitting conditions with at rest and dynamic reaching as well as forward trunk flexion with functions performance and HHC during ADL activities using the following research tools NDFI, Universal Goniometer, SACND, IRO and RSADLOT (Table 5: Tools, Numbers: 2,3,4,5,6). Status of participants' competence and QOL were also evaluated using the following research tools: NDFI and PSPCICCP (Table 5: Tools, Numbers 2 and 9).

#### A2 Baseline post-Intervention Test 1 (B) (See Table 8)

Data-collection A2 was identical to the quantitative data-collection in A1, but with fewer tools and without the stage of body measurements. Stage 2 focused on Goniometry, SACND and IRO tools, but focusing this time on evaluating free independent sitting on a stool with rest and dynamic reaching as well as forward trunk flexion, all of which were used in the performance of functions. This performance was the result of controlled water therapy in a PIA environment with the TTC. The effect of the water B intervention environment was then evaluated (Table 8).

#### A3 Baseline post-Intervention Test 2 (C) (See Table 8)

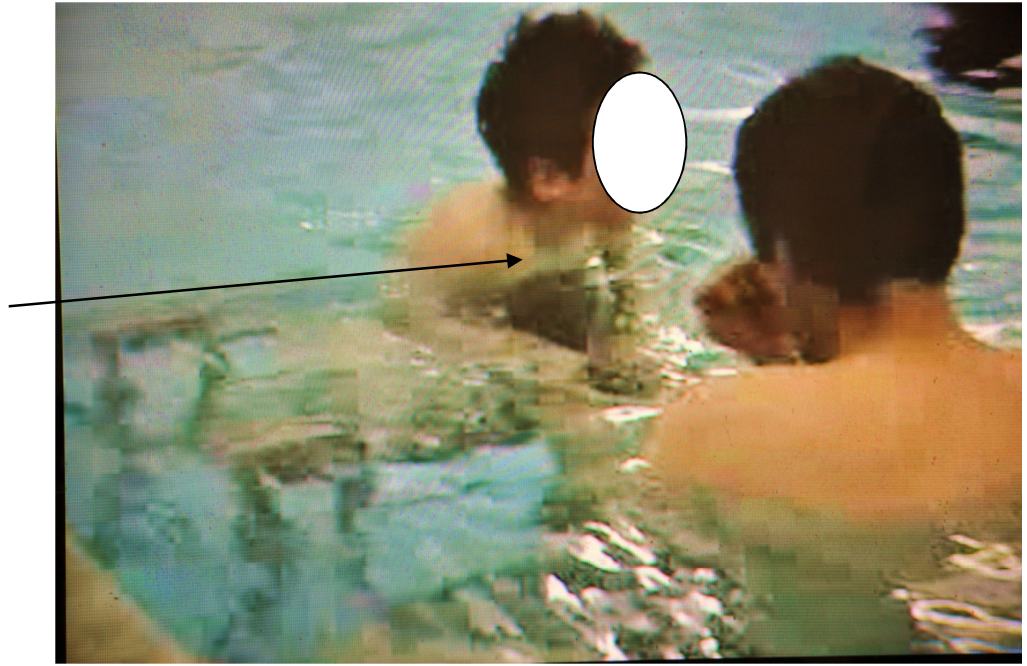
Data-collection A3 was identical to Data-collection A1, also producing quantitative and qualitative data but without body measurements and GMFCS tool. Nevertheless, although identical exercises according to participant were practised in A3 to those used in A1 and A2, at this stage the intervention employed two different successive environments (water and land-C intervention-Table 8) in which the treatment took place: the first, a controlled PIA environment that constituted a water environment intervention and the second, a land environment intervention also based on the PIA but without the TTC, using instead a specially designed stool which was also used for all the participants' evaluations which took place on land alone.

#### A4 Baseline Follow up Post-Intervention Evaluation, One Year After Treatment Termination

The identical interview questions was used for data-collection in A1, A3 and A4 (Table 8). It was used to produce qualitative data, one year post-intervention, using a comparison of NDFI to develop coded categories from interviews with parents (McBurney et al., 2003) and the child with CP that focused on: the participants' sitting conditions and their consequent improvement of HHC during ADL functions' performance and the status of the participants' PC, family dynamics and QOL. This process enabled the researcher to reinforce the validity/trustworthiness of all qualitative data (Stake, 1995, 2000; Morse, 2006a; Stamm et al. 2008) E.g. *'Time triangulation expanded by Kirk and Miller (1986) to include diachronic reliability-stability [of phenomenon] over time'* (Silverman (1993) in Cohen et al. (2000) p.113). and then validated against quantitative data. Thus, both types of data confirm the phenomenon. *'In triangulation, a researcher deploys "different methods"...to "validate" findings'* (Richardson, 2003 p.517, )(from p.9 above).

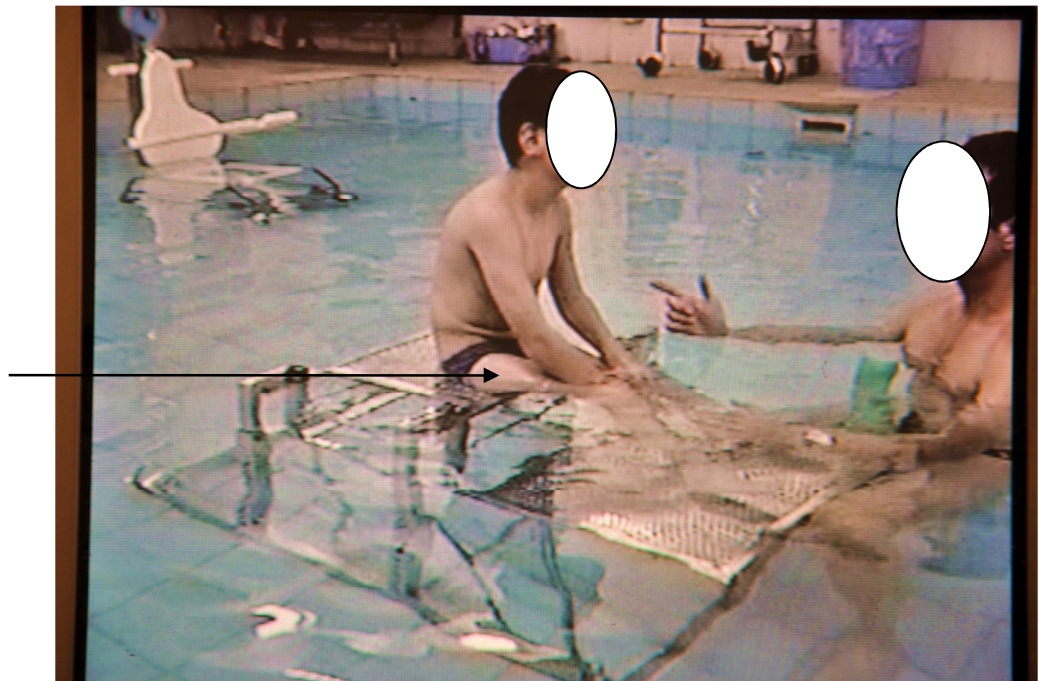
In the present study, two treatment intervention variables were used: the first was the Strength Posture of the Trunk (SPT) for **Moshe**-pilot, and **Manor** and **Avi's** case-studies and the second, SPT alternated on every other treatment day with ADL, Skills Function (ADLSF in **Maor** and **Keshet's** case-studies). These treatments were performed under changing environmental conditions (Appendix 5: Tables 1 and 2.) All cases received exercises for a total of four one-hour sessions per week (Barnes, 1989; Richards et al., 1997; Borggraefe et al., 2008), except the pilot, who received 5 treatments per a week and the additional land treatment for **Manor** and **Avi** that included 7 treatments per week (Table 6).

Picture 1 below shows the starting point for all treatments: water height-support of buoyancy at chest level during sitting on the TTC while most of hands and upper extremities are in the water supported by buoyancy, (to see levels of immersion that control percentage of body weight see Appendix 2: Figure 1). Body immersion-RCPWB was reduced by 30mm once/twice per a week-(Table 6) till the water height reached hip level (Picture 2), so that the upper extremities were loaded with gravity.



Picture 1: Participant Unloaded

Note: Arrow point indicates water line

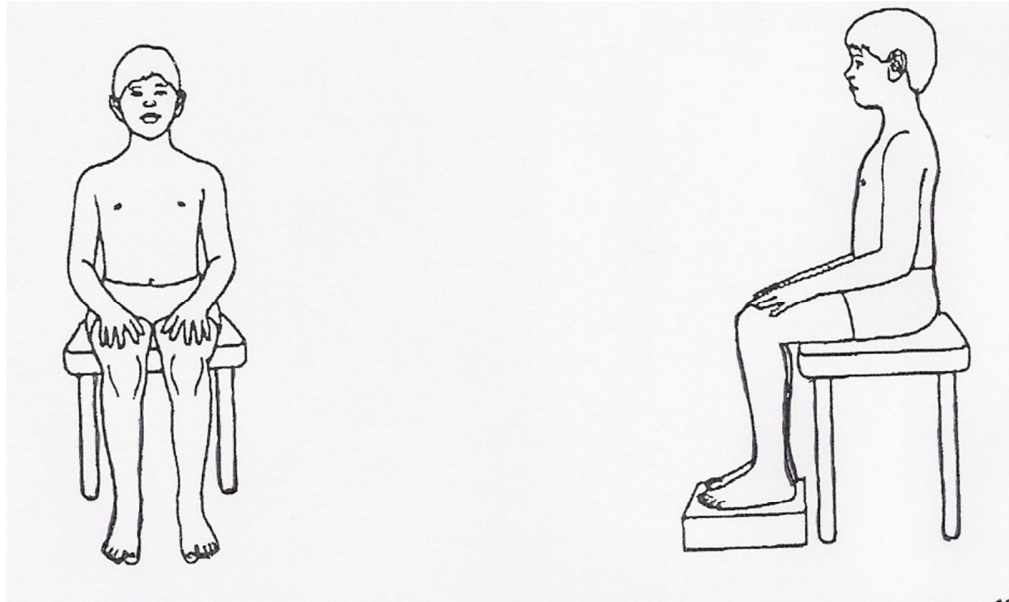


Picture 2: Participant Loaded

Note: Arrow point indicates water line

### Base Sitting Position

Base Sitting Position is defined as: free sitting on a stool and on the TTC in an erect position, legs as close as possible to 90-degree angles at the hips, knees and ankles, legs parallel and pelvis-width apart, hands resting on legs (Reid, 1995, 1996, 1997).



Source: (Reid, 1997, p.7)

**Figure 5: SACND Recommended Sitting Position**

The treatment set is described below:

**SPT-** was provided for all participants (including pilot) in accordance with the definition of balance by Reid (1997, p.4) and with '*Trunk Control Assessment*' of Preston (2001, pp.376-378). SPT and was identical whether performed in water or on land.

Task exercises for SPT started from the Base Sitting Position and always returned to it.

One set of treatments consisted of two flexions of the trunk diagonal toward the left knee, the aim being to touch the guiding researcher's finger with the nose, (head leading the movement) then trunk extension back to the Base Sitting Position. Then two flexions forward, four flexions diagonal toward the right knee, two flexions forward and two flexions diagonal toward the left knee: a total of 12 repetitions equaled one set. The range of participants' total treatment progressed from 10 sets and a total of 120 repetitions per treatment to a maximum of 30 sets and a total of 360 repetitions per treatment.

**ADLSF-** related to skills-training involving hand-to-head coordination, all beginning from the Base Sitting Position: holding the tool, bringing it to the target, bringing it back from the target and returning to the Base Sitting Position. All skills were attempted first with the left hand, then with the right, and then with both hands. A complete set consisted of: **1.** holding a water gun, reaching with it, pointing it forward and splashing water; **2.** bringing a napkin to the mouth; **3.** bringing a microphone to the mouth; **4.** putting a toothbrush in the mouth; **5.** bringing a hair brush to the hair; **6.** bringing binoculars to the eyes; **7.** bringing a hat to the head and putting it on; **8.** bringing a cellphone to the ear; **9.** bringing glasses to the eyes; **10.** bringing a whistle to the mouth and blowing into it.

### Rhythmical Intention

Rhythmical Intention was introduced in Stages 1 and 4 of the research (Table 3). The rhythm is created with an electrical metronome (*CE Qwik Time Quartz Metronome 1XS006P 9V*, made in China, EC 1995). The rhythm is established and then increased as the treatments progress. The average treatment starts with 45 to 65 beats per min. For example, the SPT treatment would be '*I flex my trunk forward, one, two, three, four, five*' and '*I extend my trunk back*' etc. (Leon, 1987, p.18; Hari and Akos, 1988, p.209).

An example of the Rhythmical Intention in ADLSF treatment would be the researcher announcing '*I bring the whistle to my mouth*'; the participant repeats the announcement, both (participant and researcher) counting from one to five. The action should end on the count of five.

In addition, participants maintained their regular individual treatments in other settings (Bower, Michell, Burnett, Campbell and McLellan, 2001; Christiansen and Lange, 2008), but without increasing or decreasing it.

To view each participant's intervention plan see Tables 6 and 7 below.

**Table 6:**  
**Details of All Treatment Interventions by Participant**

Name / Case Study	Sessions per week Water or Land	Reduction Of Body Immersion (Millimetres)	Amount of chair lifts per week	Session Time Water or Land (Minutes)	Number of Water and Land Intervention Sessions	Total Intervention		Days between pre-and post-treatment 2
						Time Water / Land (Minutes)	Session	
Moshe-pilot study	Water-5	Brick-80	2/week	Water-45	Water-16	Water- 720	16	19 days
Manor-research participant	Water-4	Therapeutic Treatment Chair- 30	2/week	Water-60	r-Water-20	r-Water-1200	102	147 days
	Land- 7	—	—	Land- 10	Land- 82	r-Land- 820		
Avi-control participant	Land- 7	—	—	Land- 10	Land- 82	c-Land- 820	82	147 days
Maor participant	Water-4	Therapeutic Treatment Chair- 30	1/week	Water-60	Water-24	Water-1440	44	77 days
	Land- 4	—	—	Land- 60	Land- 20	Land- 1200		
Keshet participant	Water-4	Therapeutic Treatment Chair- 30	1/week	Water-60	Water-16	Water- 960	43	83 days
	Land- 4	—	—	Land- 60	Land- 27	Land- 1620		

**Table 7:**  
**MMD Showing Details of Interventions According to Participants and Base Lines,**  
**using Quantitative Core and Supplementary Qualitative Methods**

<b>A1</b> Baseline	<b>B</b> Intervention	<b>A2</b> Baseline	<b>C</b> Intervention	<b>A3</b> Baseline	<b>D</b> Intervention	<b>A4</b> Baseline
Pre- Intervention	PIA Water Sessions	Post- intervention test 1 (B)	Land Intervention	Post- intervention test 2 (C)	One year period: testing stability of QOL findings over time	One year post- intervention
Moshe (P) Quantitative	16 = SPT 45 minutes, 5per week	Quantitative				32 months Qualitative
Manor (r) Quantitative Qualitative	20 = SPT 60 minutes, 4per week	Quantitative	+82 = SPT 10 minutes, 7per week	Quantitative Qualitative		Qualitative
Avi (c) Quantitative Qualitative	0=SPT	Quantitative	+82 = SPT 10 minutes, 7per week	Quantitative Qualitative		Qualitative
Maor Quantitative Qualitative	24=SPT+ ADLSF, 60 minutes, 4per week	Quantitative	+20 = SPT+ ADLSF,60 minutes 4per week	Quantitative Qualitative		Qualitative
Keshet Quantitative Qualitative	16=SPT+ ADLSF, 60 minutes 4per week	Quantitative	+27 = SPT+ ADLSF,60 minutes 4per week	Quantitative Qualitative		Qualitative

KEY TO TABLE: 7

ADLSF	Activities of Daily Living, Skills Function	P	Pilot study	r	Research participant
c	Control participant	QOL	Quality of Life	SPT	Strength Posture of the Trunk



## **3.12 Data Analysis and Interpretation**

### **3.12.1 Preferred Strategy to test the ability of the PIA to develop Participants' Skills**

The research quest was to test a number of complex issues mentioned in the Introduction, Chapter 1: Selection of Methodology to strengthen Internal Validity.

Nachmias and Nachmias (1996) indicate that there are two problematic issues which are relevant at this point with regard to case study: (1) extrinsic factors-prior to research e.g. the constrictions leading to the selection of a small sample and (2) intrinsic factors-during the research, e.g. measuring-testing sitting position during clinical evaluation, which may affect the internal validity and reliability of the study. The researcher therefore aimed to increase the rigour of the study data by using between methods, investigator, time and data triangulations, but was also conscious that *'designs that are strong on internal validity ... tend to be weak on external validity'* (p.147).

MMD was chosen because the researcher wanted to test hypotheses concerning a specially constructed PIA-theory so that the researcher needed to *'use criteria for evaluating [testing] theory'* (Glaser, 1978; Morse, 1997 in Morse, 2006b, p.6). This meant that it was necessary to test 'How' or 'Why' the PIA is effective/ ineffective. The researcher therefore compared data from quantitative and qualitative NDFI tool before and after intervention-(using identical procedures, questions, format order and respondents (Morse and Niehaus, 2009) to test the child's adaptation status regarding: motor function, competence and QOL. Interviews with the child, parents, Physical Therapist and/or Conductor, Conductor Assistant, Teacher, Teacher's Assistant and caregiver were tape-recorded (McBurney et al., 2003).

### **3.12.2 Developing a Multiple Case Study with MMD**

The researcher chose the multiple case study strategy (Yin, 2003), to improve the reliability/validity of the data. Herriott and Firestone (1983, in Yin, 2003, pp.46-47) claim that *'the evidence from multiple cases is often considered more compelling, and the overall study is therefore regarded as being more robust'*. The principle of such replication logic is *'analogous to that used in multiple experiments'* (Hersen and Barlow, 1976 in Yin, 2003, p.47).

### 3.12.3 Developing a Cross-Cases Protocol and Study Data Base

This procedure is based on the principle that collected quantitative and qualitative data should be systematically organised for analytical or reporting purposes, and so that other investigators can review the research evidence. The production of the protocol through a detailed database in the present study was recorded in the Appendices and researcher's diary. These tools helped the researcher conduct self-reflection, and debriefing of the research process and improved the reliability of all the cases (Yin, 1984, 1993, Shkedi, 2003; Stamm et al., 2008).

### 3.12.4 Two Strategies of Data-Analysis

The selected method of analysis for the collected data was based on two strategies and on integration of data analysis using types of triangulation.

#### Quantitative Analysis

The first strategy employed was replication logic applied to results across four case studies (Yin, 1984; 1993; Firestone, 1993; Merriam, 1998), according to the guidelines of Yin (2003) within an MMD (Morse and Niehaus, 2009) thus increasing confidence in the robustness of the research findings.

Quantitative data was collected before the research commenced and throughout the research and one-year post-intervention. Morse (2007b) indicates that *'Sometimes data collection will be competing with complex treatments'* (p.864) and this was indeed the case in the present interventions. The quantitative data analysis took place in stages according to the RQ and the type of research tools used. This analysis was based on two main calculations:

1. First, Anastas and MacDonald (1994, p.204) who suggested the use of a treatment sequence denoted by the letters **'A/B/A/C/A/D/A'** found that *'Sometimes multiple treatments or interventions may be employed with a single case ... because the several problems being assessed (multiple baselines) may require differing interventions. Such an additional treatment is typically labeled "C" (or "D" or "E" as numbers mount)'*. In the pre/post-tests intervention design employed according to this sequence formula the research tools that produced the research data (presented in graphs in Chapter 4) were: Goniometry-Graph 1: SACND-(the At Rest-Graph 2: and Reaching-Graph 4:) and IRO (Graph 3). The analysis of data collected with these tools focused on calculation of differences between results at different base lines (pre- and post-intervention in A/B/A/C/A/D/A strategy) and between cases as follows (see Table 8 below):

- a. A1-Baseline and the difference between evaluations of A2-post-intervention test 1(B) produced the result for PIA-water intervention-**(B)**.
  - b. A1- Baseline and the difference between evaluations of A3-post-intervention test 2(C), produced the result for PIA-water and land intervention-**(C)**.
  - c. A2- Baseline of 1(B)-PIA-water intervention and the difference between evaluations of A3 the 2(C)-PIA-water and land intervention, produced the result for PIA-land intervention-post-intervention test 3, this finding was based on calculation but was **not** in fact a separate type of physical intervention that was practised with the participants.
  - d. The **(D)** intervention assessment took place one year after the treatment terminated (except for the pilot case which took 2.8 years) to investigate the effects of the intervention on the level of QOL of all participants and their families after the intervention process. Qualitative data was gathered by comparing the last baseline stage **(A4)** evaluation, which collected emergent NDFI data and analysed it by developing coded categories with similar data from baseline **(A1)** and **(A3-Table 8)** to develop interpretation regarding the QOL phenomenon.
2. The second quantitative analysis calculation was based on the total difference between pre-intervention and post-intervention findings, gathered with the use of the following research tools: RSADLOT, GMFM and PSPCICCP (Table 8: result at A1 base line of pre-intervention is subtracted from result at A3 post-intervention test 2) (analysed in Chapter 4: Findings, Graphs: 5 and 6, and Table 18).

**Table 8: MMD showing Details of Data Collection and Analysis according to Base Lines, Quantitative Core and Supplementary Qualitative Tools**

<b>A1</b> Baseline	<b>B</b> Intervention	<b>A2</b> Baseline	<b>C</b> Intervention	<b>A3</b> Baseline	<b>D</b> Intervention	<b>A4</b> Baseline
Pre- Intervention	PIA Water	Post- intervention test 1(B)	PIA Water and land Intervention	Post-intervention test 2(C) Calculated Post- intervention test 3	One year period: testing stability of QOLfindings over time	One year post- intervention
Core- Quantitative Tools:		Core Quantitative Tools:		Core- Quantitative Tools:		Emergent Design Qualitative
Goniometry SACND IRO RSADLOT GMFM GMFCS SPCICCP		Goniometry SACND IRO		Goniometry SACND IRO RSADLOT GMFM  PSPCICCP		
Supplementary Qualitative Tool: NDFI				Supplementary Qualitative Tool: NDFI		Tool: NDFI

KEY TO TABLE 8:

GMFCS	Gross Motor Function Classification System	IRO	Interval Recording Observation	PSPCICCP	Pictorial Scale of Perceived Competence in Israeli Children with CP	SACND	Sitting Assessment for Children with Neuromotor Dysfunction
GMFM	Gross Motor Function Measure	NDFI	Non- Directive Focused Interview	RSADLOT	Rating Scale ADL, Observation Test		

**A. A/B/A/C/A/D/A analysis employed by Goniometry, SACND and IRO tools.**

Goniometry: The Universal Standard Goniometer 'Baseline TM' Chattanooga Group Inc. built to measure joint Range Of Motion (ROM) by a scale of degrees, has been shown to be very reliable (Boone et al., 1987; Riddle et al., 1987). Prior to each set of measurements the goniometer should be carefully calibrated against a digital, angle analyser of Metzger No. 02169, with a known angle of 50°-60°-70°.

The goniometer measured ROM according to two approaches:

1. Passive ROM according to Esch and Lepley (1981).
2. Active ROM in a sitting position on the test chair.

Static Passive Evaluation of Hip Flexion

**Testing position:** Supine, legs parallel, in contact with the table.

**Goniometer placement: Fulcrum** - centred on the hip, marking axis' movement (Greater Trochanter).

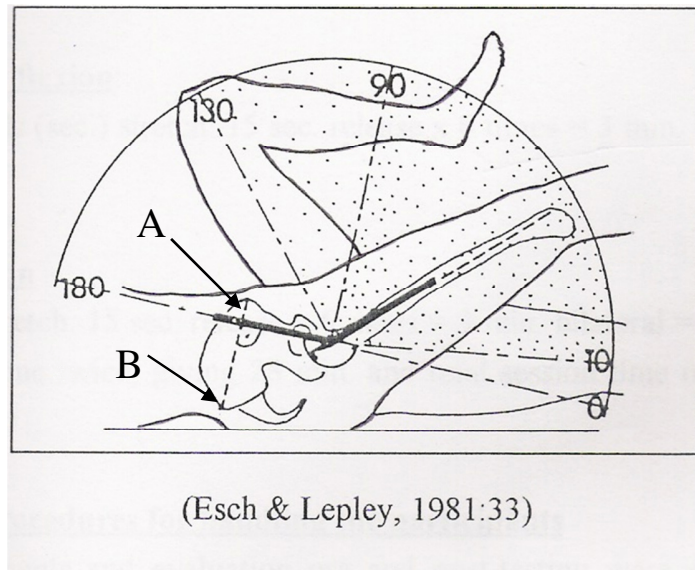
**Stationary arm:** perpendicular to the line of Anterior Superior Iliac Spine and Posterior Superior Iliac Spine (Esch and Lepley, 1981, p.33, see also Figure 6 below, Stuberg, Fuchs and Miedaner, 1988, p.660), and a 90 degrees triangular ruler assist in placing stationary arm perpendicular to above mention line.

**Movable arm:** *'parallel to the longitudinal axis of the femur'* (Esch and Lepley, 1981, p.33).

Marking Axis Places on the Participant's Body.

- A. To mark the Greater Trochanter: Participant standing on his legs and holding on to support such as: wall, stable chair etc.
- B. To mark the Anterior Superior Iliac Spine, participant standing and supported by a wall.
- C. To mark the Posterior Superior Iliac Spine: participant standing and supported by a wall. (The point is 1.5 to 2 fingers lateral to the second Sacrum spine (Davies, 1967)). A line is drawn from Anterior Superior Iliac Spine to the Posterior Superior Iliac Spine.

See Figure 6: A, and B below.



**Figure 6: Goniometer Placement and Operation**

A. Anterior Superior Iliac Spine      B. Posterior Superior Iliac Spine

#### Measurement of Active ROM

For the evaluation, the participant is placed in a free sitting position on a stool. The size of the test stool for each individual was calculated according to the size of his/her lower extremities, following the protocol and procedures of Reid (1997, pp.3-4, See also Reid, 1995, p.59). The height of the stool should allow the child's feet to rest comfortably on the floor, maintaining, as closely as possible, 90-degree angles at the hip, knee and ankle joints (Reid, 1995; 1996;1997).

The assistant, sitting in front of the participant, supports the child, with both hands in contact with the participant's hands. The assistant asks the participant to flex their trunk forward as far as the child can but it is emphasised that child should be able to return to an erect sitting position without leaning on the assistant's hands as balance is defined in the SACND test: (Reid, 1997).

Trunk Flexion Testing Position: free sitting position, legs parallel, as close as possible to 90 degrees at the hip, knee and ankle joints.

*'Goniometer placement: fulcrum centred on the hip, marking axis' movement (greater trochanter)* (Shelef, 1998, p.33).

*Stationary arm: 'parallel to the longitudinal axis of the femur'* (Esch and Lepley, 1981, p.34).

*Movable arm: 'parallel to the longitudinal axis of the trunk'* (Esch and Lepley, 1981, p.34).

### Testers

Shelef (1998), used a single rater, which is more reliable and involves fewer variables than measurements involving a number of raters (Low, 1976; Boone et al., 1978; Riddle et al., 1987; Stuberg et al., 1988; Witt and Parr, 1988; Holland and Steadward, 1990).

A trained and experienced rater ensures the reliability of the results (Stuberg et al., 1988; Sutton, 1993). Therefore, to improve reliability and repeatability the researcher and assistant underwent nine in-service training sessions (Appendix 13). It was evident that the researcher's: *'greater experience from clinical practice was an advantage'* (Myhr et al. 1993, p.32).

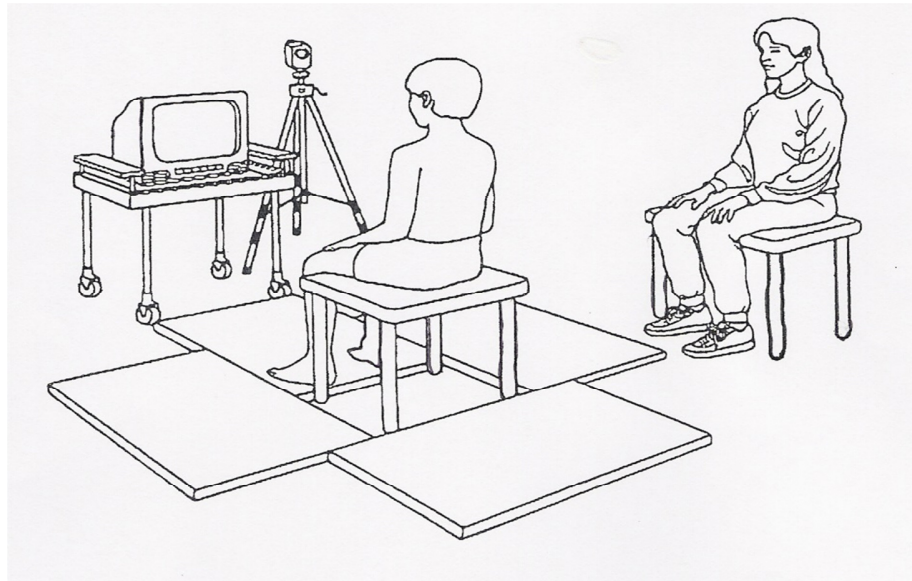
To prevent bias, the goniometer scale was covered with adhesive tape for the duration of the study, so as to ensure that the researcher would be *'blind to previous results'* (Stuberg et al., 1988, p.665). The goniometer was carefully handed to the assistant who recorded the results (Riddle et al., 1987; Stuberg et al., 1988; Templeton, Booth, and Okelly, 1996; Shelef, 1998).

The hip-flexion ROM of both joints (in degrees) was evaluated three times, and the mean was considered as the result (Low, 1976; Boone et al., 1978; Hoshizaki and Bell, 1984; Williford, East, Smith and Burry, 1986; Stuberg et al., 1988; Templeton et al., 1996).

### Sitting Assessment for Children with Neuromotor Dysfunction (SACND)

SACND rest and reach models assessment protocol were applied according to Reid (1997, p.10). The participant sits on the test stool, mats having been placed around it for safety. In front of the stool is a TV and videorecorder placed at the child's eye level.

*'Position the video camera [on tripod] 5-6 feet in front of the bench and off to one side (approximately 45 degrees from midline)'* (Reid, 1997, p.14; see Fig. 7 below). *'The video assessment is the most objective assessment and is looking strictly at actual performance ("does do" rather than "can do")'* (Russell et al., 1993, p.11; see also Myhr et al., 1993; Stake, 1995; Richards et al. 1997; Lepore et al. 1998; for ethical considerations, see Knight, 2002).



(Reid, 1997, p.10)

**Figure 7: Rest Assessment Situation**

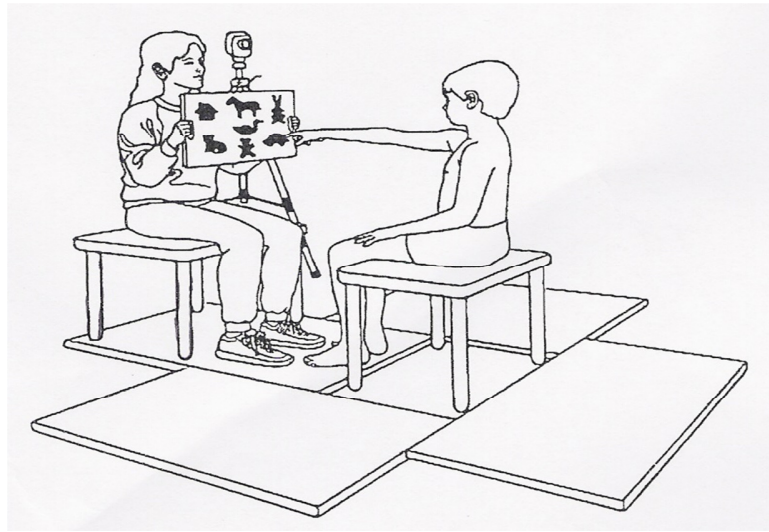
#### Rest (Static) Assessment

The assistant is seated close to the participant in a close guarding position to prevent falls during the evaluation process. Another assistant operated the video camera. The rest evaluation (Figure 7), trial lasts 7 min and 30seconds consecutive minutes, ensuring that 15 pictures are taken with the IRO tool-(digital camera) every 30seconds, while the video camera records for 5 consecutive minutes (Reid, 1997), throughout the rest evaluation. Both IRO and video camera recording the child's MP behaviour during sitting performance.

#### Reach (Dynamic) Assessment

The protocol assessment and procedures were conducted according to SACND by Reid (1997, see Figure 8 below).





(Reid, 1997, p. 12)

**Figure 8: The Reaching Ability for Functions Assessment Situation**

Assessment of reaching needs similar safety requirements for static assessment and it lasts 5 consecutive minutes. During this time, the assistant operates and holds the board displaying different figures (see Figure 8 above) and another assistant operates the video camera, all according to guidelines of Reid (1997, p.12)(Administering and scoring the SACND, Appendix 14).

#### Interval Recording Observation (IRO)

A digital camera is placed perpendicular to the participant, on a tripod (dimensions and distances are detailed in Table 5: Tools, No. 5; Appendix 15: Mapping Sports Hall at Tamar School) taking a picture every 30 seconds for total time of 7min and 30seconds, thus 15 pictures are collected.

The calculation analysis for IRO was performed in three stages:

1. Each judge was shown photographs of the participant's sitting position from an album (Appendix 17: See Five Examples), and classified the pictures as good, medium or low (Appendix 17: IRO: Example of good sitting, intermediate sitting and low sitting). These classifications were calculated in percentages. (See Appendix 18: IRO-a picture every 30seconds-Table 1).

2. At each measuring point, the average of the three judges' ratings was calculated (See Appendix 18 Table 2).
3. Differences in the averages were calculated between each measuring point and the previous point (See Appendix 18 Table 3: Numbers marked in blue).

## **B. Pre-post-intervention Analysis employed by RSADLOT, GMFM, GMFCS and PSPCICCP Tools**

### Rating Scale ADL, Observation Test (RSADLOT)

This was used for analysis of the basic pre-post-test difference due to the intervention and was used with RSADLOT, GMFM and PSPCICCP tools.

RSADLOT was developed by the researcher because there was no tool available at that time with high sensitivity to evaluate ADL skills during sitting that affects child's hands-head coordination during functioning. The tool was based on the GMFM instrument (RSADLOT scale and scoring key in Appendix 16).

**Table 9:**  
**Total summary and calculation score of participant with tools:**  
**RSADLOT and GMFM**

Name of Tool	Subject of Dimension Measurement	Total Dimension Score	Number of Items-Checkte Veribelse	Dimension Percent Scores
RSADLOT	A. Functional touching of body parts	?	5	A%-?
RSADLOT	B. Functional ADL skills	?	17	B%-?
GMFM	A. Lying and Rolling	?	51	A%-?
GMFM	B. Sitting	?	60	B%-?
GMFM	C. Crawling and Kneeling	?	42	C%-?
GMFM	D. Standing	?	39	D%-?
GMFM	E. Walking, Running and Jumping	?	72	E%-?

Dimensions

Example. of Calculation of Dimension Percentage Scores

GMFM-Walking, Running and Jumping  $\frac{\text{Total Dimension E} = ? \text{ times } 100}{\text{No of items}=72} = \text{E}\%$

**Total Score=**  $\text{RSADOL-A}\% + \text{B}\%$  or  $\text{GMFM-A}\% + \text{B}\% + \text{C}\% + \text{D}\% + \text{E}\% = \text{Participant \%}$

Total Dimension= RSADLOT=2 or GMFM= 5

(Russell et al. (1993), p.37).

### Gross Motor Function Measure Manual (GMFM)

Russell et al. (1993) suggest that *'the GMFM is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with cerebral palsy'* (p.33). The tool evaluated 5 dimensions: see Table 9 above.

The scoring key for GMFM is: '0=does not initiate 1=initiates 2=partially completes task 3=completes task'...'. Unless otherwise specified, 'initiates' is defined as completion of less than 10% of the item. 'Partially completes task' is defined as completion of 10% to less than 100%' (p.33).

### Gross Motor Function Classification System (GMFCS)

Palisano et al. (1997) developed this tool

*to address the need for a standardized system to classify the gross motor function of children with cerebral palsy' (214)...'The scale is ordinal...[with] 5 levels...LEVEL I-Walks without restrictions; limitations in more advanced gross motor skills...LEVEL II-Walks without assistive devices; limitations walking outdoors and in the community (p.221)...LEVEL III-Walks with assistive mobility devices; limitations walking outdoors and in the community...LEVEL IV-Self-mobility with limitations; children are transported or use power mobility out doors and in the community...LEVEL V-Self mobility is severely limited even with the use of assistive technology' (p.222).*

The tool was only used in the pre-intervention test to justify participants' inclusion according to selection criteria.

### Pictorial Scale of Perceived Competence in Israeli Children with CP (PSPCICCP)

The tool evaluated participants' differential results between pre-post-intervention tests. The scoring key for the rating scales questionnaire- uses a scale of four levels, from 1 to 4. Rating for each question is as follows: 1. Bad=1 point 2. Almost good=2 points 3. Good=3 points 4. Very good=4 points (Schneider, 1996).

### Calculation of Participant Percentages Score

Adding points for all questions = total participant's points result

Times-X 100= participant percentages score-%

Maximum of total score for all questions = 228 points.

### Qualitative Analysis

The second data analysis was employed on data from qualitative NDFI following the suggestions of Glaser and Strauss, (1967); Stern, (2009a) Stern and Kerry, (2009); Charmaz, (2009); Corbin, (2009); Morse et al. (2009); and Strauss and Corbin, (1998, p.79). Data from the NDFI underwent open coding: and were broken down for analysis '*comparing incident to incident*' [and searching] '*for similarities and differences and ...* [the selected data are then] *grouped or placed into a category*'.

Next came the process of reassembling the interpreted data: this is termed axial coding connecting categories and subcategories, and developing core categories or theoretical categories '*comparing categories (abstract concepts) to similar or different concepts to bring out possible properties and dimensions* (p.94). This process drew a comparison between A1, A3 and A4 base lines (Table 8). This enabled the researcher to provide a better explanation of the phenomenon by identifying the reasons and conditions of action for the phenomenon being investigated.

### Integration of Data Analysis

Morse and Niehaus (2009) suggest that a researcher employing an MMD should '*interface the two data sets either in the analysis or to merge [them] in the findings*' (p.48) although they should '*keep the qualitative data as qualitative data [till the point of integration],...and incorporating insights into the results narrative*' (p.49) as constructed in the present study.

Table 10 below summarises the different types of triangulation used in this research to compare and analyse the data across different base lines. The types of triangulation are presented according to their use in response to the different research questions. However, combinations of triangulation across cases, questions and tools are also used to verify the results.

**Table 10:**  
**Triangulation Strategies employed in response to Research Questions**

<b>Research Questions</b>	<b>Between Methods Triangulation (Tools)</b>	<b>Investigator Triangulation (Tools)</b>	<b>Time Triangulation (Tools)</b>	<b>Data Triangulation (Method)</b>
Question 1: Table 13	Goniometry SACND (rest) IRO	SACND (rest) IRO	Table 8: NDFI A1 compared to A3 base line	Quantitative compared to Qualitative
Question 2: Table 16	SACND (reach) RSADLOT GMFM	SACND (reach) RSADLOT	Table 8: NDFI A1 compared to A3 base line	Quantitative compared to Qualitative
Question 3: Table 19	PSPCICCP NDFI		Table 8: NDFI A1 compared to A3 base line	Quantitative compared to Qualitative
Question 4: Table 20	Goniometry SACND IRO RSADLOT GMFM PSPCICCP	SACND (rest and reach) IRO RSADLOT	Table 8: NDFI A1 compared to A3 and A4 base lines	Quantitative compared to Qualitative

KEY TO TABLE 10

GMFM	Gross Motor Function Measure	NDFI	Non-Directive Focused Interview	RSADLOT	Rating Scale ADL, Observation Test
IRO	Interval Recording Observation	PSPCICCP	Pictorial Scale of Perceived Competence in Israeli Children with CP	SACND	Sitting Assessment for Children with Neuromotor Dysfunction

The results of the triangulation of quantitative and qualitative findings are presented in Table 11 below.

**Table 11:**  
**Summary of Quantitative and Qualitative Research Findings**  
**collected in response to the Four Research Questions**

Quantitative Findings	Qualitative Findings
<b>Question 1.</b> How and why did the posture and balance abilities of participants with CP change during free sitting on land, after the PIA intervention?	
<p>All participants displayed a great improvement in quality of free sitting during rest and balance.</p> <p><b>Efficiency of intervention:</b> Post-intervention test 1: PIA water treatment, produced better results in proportion to the amount of treatment when compared to other treatments.</p> <p><b>Highest results of intervention:</b> Post-intervention test 2: PIA water and land treatment. This is the longest intervention with the greatest contribution to free sitting quality and balance.</p> <p><b>Lowest results of intervention:</b> Post-intervention test 3: land treatment alone produces lowest results which is less beneficial to free sitting quality and balance than treatments 1 and 2.</p>	<ul style="list-style-type: none"> <li>▪ Improved upright position and sitting quality</li> <li>▪ There is no more fear of falling</li> <li>▪ Improved sitting for a relatively long time</li> <li>▪ Improved independent sitting</li> <li>▪ Improved motivation</li> <li>▪ Improved feeling of confidence</li> <li>▪ Improved sitting as a result of the partially immersed approach using the therapeutic treatment chair</li> </ul>
<b>Question 2.</b> How and why did the Hand-Head Coordination (HHC) used in functional Activities of Daily Living (ADL) abilities differ for participants with CP during free sitting on land, after intervention?	
<p>All participants displayed improved quality of HHC used in ADL skills functions.</p> <p><b>Efficiency of intervention:</b> Post-intervention test 1: PIA water treatment, produces the best results in proportion to the amount of intervention.</p> <p><b>Highest results of intervention:</b> Post-intervention test 2: PIA water and land is the longest intervention with the greatest contribution to dynamic reaching during free sitting.</p> <p><b>Lowest results of intervention:</b> Post-intervention test 3: showed land treatment alone, provided a lower contribution to the quality of dynamic reaching during free sitting.</p> <p>Maor and Keshet show a large improvement compared to Manor and Avi in HHC used in ADL skill function.</p>	<ul style="list-style-type: none"> <li>▪ Improved quality of hands function when sitting</li> <li>▪ Improved HHC of ADL skills</li> <li>▪ Improved reaching out</li> <li>▪ Improvement in fingers' flexibility and movement</li> <li>▪ Improved independent functioning</li> <li>▪ Fear of falling</li> <li>▪ There is no more fear of falling</li> <li>▪ Improved in motivation</li> <li>▪ The water reduces fear of falling</li> </ul>
<b>Question 3.</b> How and why did the PC of participants with CP vary as a result of the intervention?	
<p>The participants' level of PC improved dramatically after the intervention treatment.</p> <p>The highest PC was achieved by: First Avi, second Keshet, third Manor and fourth Maor.</p>	<ul style="list-style-type: none"> <li>▪ Physical motor success improves emotional state.</li> <li>▪ Improved behaviour.</li> <li>▪ Social improvement.</li> <li>▪ Improvement in school environment.</li> <li>▪ Improved in motivation.</li> </ul>

<p>The total mean percentage of increase for PC after the treatments is 17.65% of all participant.</p>	<ul style="list-style-type: none"> <li>▪ Improved motivation of the parents.</li> <li>▪ Improved confidence and self image/ self-esteem.</li> <li>▪ Improves in determination.</li> <li>▪ Improves acquisition of physical skills.</li> <li>▪ Improved physical ability.</li> </ul>
<p><b>Question 4.</b> How and why was the QOL of participants with CP altered as a result of the intervention, and at follow-up one year after intervention?</p>	
<p style="text-align: center;"><b>Quantitative Findings</b></p> <p>Quantitative improvement in: hip flexion ROM, free at rest sitting, dynamic reaching during free sitting, ADL skills functioning using HHC during free stool sitting, gross motor function and Perceived Competence (PC).</p>	
<p><b>Qualitative Findings Before and After Intervention</b></p>	<p><b>Qualitative Findings One Year After Termination of PIA intervention</b></p>
<ul style="list-style-type: none"> <li>▪ Improved upright sitting, enhanced physical functioning with ADL skills e.g. eating.</li> <li>▪ Improved sitting posture enhancing self-psycho-social domains</li> <li>▪ Improved sitting posture enhancing world discovery-adaptation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Erectness and sitting quality improved including functional performance: Preservation of sitting skills.</li> <li>▪ Improved psychological characteristics related to personality, GSW (also referred as self-esteem) and PC.</li> <li>▪ Recommendations and desire to continue with the therapy completed a year ago.</li> <li>▪ As a result of the research, the parents/caregivers took the initiative and changed behavioural strategies and attitude relating to therapy, sensitivity and in general, and in giving their time to the child.</li> <li>▪ Following the research, there are descriptions that indicate improvement and influence on, closer and healthier family activities and interaction.</li> </ul>

\* Partially Immersed Approach (PIA)

### 3.13 Four Research Stages

**Stage 1:** see Table 3

#### 3.13.1 The Pilot Study

The Effectiveness of a Water Therapy Environment with Manipulation of Buoyancy to improve Sitting and Function of Cerebral Palsy Adolescents: A Pilot Study.

The pilot study evaluated the sitting qualities of adolescents with CP during the manipulation of buoyancy in a heated swimming pool environment. The main objective of the study was to envisage possibilities and discover a strategy and develop a special treatment environment within what is known as the PIA (Harrison and Bulstrode, 1987; Harrison et al., 1992). The intention was to employ this environment with its unique benefits for the rehabilitation of the sitting condition and posture of children with CP. PIA is based on the principle that due to: *"the upthrust of the water, the effective weight of a partially immersed subject will decrease in proportion to the degree of immersion"* (Harrison et al., 1992, p.164).

The simple strategy which was chosen to create this environment was to place stones blocks under the legs of the treatment chair and the legs of the participant. Both legs were simultaneously raised together with coordinated control, maintaining the height of chair and the participant's legs at the same level, sustaining the same sitting posture and a constant position of the participant's legs. This strategy was used to explore possibilities of building a special chair, which could control the elevation of the participant upwards above the water line while maintaining a constant sitting position, a chair that would be designed to be used with different body sizes from child to adult.

The aims of the pilot study were:

1. To verify the research hypothesis that buoyancy manipulation could help children with CP to improve their sitting condition, posture and balance.
2. To gather knowledge and experience on the effects of treatment with buoyancy manipulation, methods of evaluation and the conditions necessary to conduct the subsequent research.



3. The goal at this stage was to prepare the necessary tools to conduct a large-scale research developing new treatment environments for treatment of the CP condition.

The volunteer participant, Moshe (pseudonym), was 15 years and 4 months old (at the time of the study), and had been diagnosed with bilateral spastic CP-GMFCS level IV (Cans et al., 2007). He attended a regular high school in the JBED. The participant was chosen due to his accessibility, congeniality, and geographical convenience (Yin, 1984, 1993). The researcher was involved in rehabilitating the participant for many years prior to the study and was familiar with his overall condition and abilities, as well as with the participant's family and environment, which strongly supported the study.

The pilot study questions were:

1. How can the participant be lifted above the water line?
2. How many treatments in the water will be needed to produce a change in sitting performance?
3. Why does gradual lifting using PIA benefit sitting performance?
4. How and why does the still camera affect the participant? Are the research instruments able to produce true data and if so how?
5. Is there a connection between sitting performance and hand-head coordination and if so, why?
6. How and whether the pilot-case study can be replicated and used to produce the next case study (Yin, 2003).
7. How can the pilot study be upscaled to examine and apply the hypothesis, methodology, data-collection techniques, data analysis, study designs, procedures and protocol to a full-scale study? All of these questions are answered above in Table 3: Stage 3 - Objectives, Study design, procedures and protocols detailed in the Appendices and the Researcher's Diary.

### The Method

The method used to evaluate the quality of sitting in the study is the MMD (Morse and Niehaus, 2009) using one pre-intervention base line (12<sup>th</sup> April 2002) and two post-intervention base line tests. The quantitative post-intervention test (1) (3<sup>rd</sup> May 2002) was conducted 12 hours after the previous treatment following an overnight sleep. The post intervention test (2) (9<sup>th</sup> January 2005) was conducted 2.8 years after the study began and produced qualitative data.

### 3.13.2 The Research Tools

The tools: NDFI, Goniometry, SACND (rest) and IRO are described in detail above in Table 5 and in the Analysis of Quantitative Tools.

The NDFI tool was used to interview the participant with his mother to investigate whether, how and why the sitting intervention had affected his QOL?

*'Case studies are the preferred strategy when "how" or "why" questions are being posed' (Yin, 2003, p.1).*

The Goniometer was used to measure ROM according to two approaches.

1. Passive ROM. in a supine position evaluation relating to both hips' flexion, according to Esch and Lepley (1981).
2. Active ROM in a sitting position on the test chair. Relating to forward flexion of the trunk and a return to an upright sitting position.

The SACND evaluates rest and reach seating during postural control of children aged 2 years and over (Reid, 1995).

IRO was used to generate data composed of photographs illustrating the best trunk position relative to the line of gravity. The participant was seated on the test chair watching a 5 Minutes (Min) videofilm. Every 30 seconds a still camera took a picture of the participant's profile. Total seating time lasted 7min, thus 28 pictures were collected from the pre- and post-intervention tests, which were lined up and compared.

The two groups of photographs were presented to 3 independent experts in the field, one at a time. The question that was asked was: *'in which picture does the participant appear to be in a better sitting position?'*

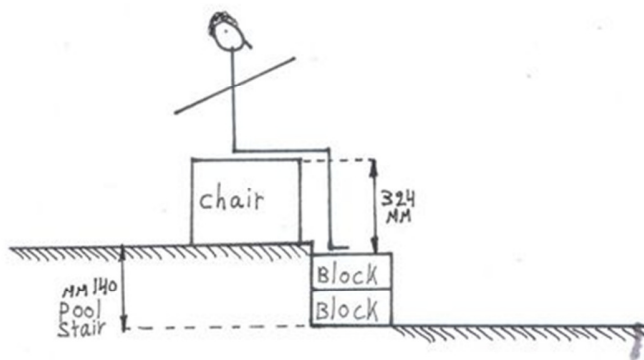
### 3.13.3 Apparatus

**Stools** The pre-intervention and post-intervention tests' evaluation of land treatment all took place on a special stool, constructed on 4 wood legs, which constituted the foundations for a sitting base measuring 410mm. in length, 375mm. in width and 20mm. thick. The height of the chair was 400mm. from the ground.

The PIA treatments took place on two special stools with identical measurements except for the height of the chairs from the ground. Both chairs sink in water. The chairs were constructed from fiberglass with 4 legs, constituting the foundations for a sitting base

measuring 650 mm. in length, 400mm. width. The height of the lower chair is 304mm. from the ground. The height of the higher chair is 404mm. from the ground.

During treatments and during the elevation of Moshe from the pool water level, the distance between the chair sitting base and the base of support for the participant legs was constantly fixed at 324mm.- see Figure 9 below.



**Figure 9: Elevation of Moshe from the Pool Water**

**Blocks:** The participant was elevated from the pool water level with stone blocks measuring 200mm. in length, 100mm. in width and 60mm. thick.

### 3.13.4 Procedures

The participant went through 16 standardised treatment sessions of 45 minutes each, over a period of 19 days. During the treatments the participant was elevated five times from the water level in steps of 60 mm. (after treatments session No: 3, 5, 7, 10, and 13) and performed exercises at each level. The participant was raised by a total of 300mm from the water, which equals the distance between his chest line and his hip joint.

**Treatments:** The treatments took place on a chair inside a swimming pool, with an average temperature of 33.8o Celsius (C), average air temperature of 26.3C, and average humidity of 95%, with the aim of improving the child's condition, posture and balance, when subsequently sitting in a land environment.

During the first treatment the water line was on the chest (30mm above nipple line), and in the last treatment it was on the Iliac Crest or Lumbar (L-4). Task exercises for Strength Posture of the Trunk (SPT) began from the Base Sitting Position.

Moshe began the tasks from the Base Sitting Position and always returned to it. (See Methodology: Interventions, pp.94-99).

**Evaluation** The pre-intervention test took place in the participant's home on the evaluation chair, in an air temperature of 22°C continuing for 7 Min. Moshe sat and watched a video of his choice. A video camera was used to film the participant in a visual range of 360° (for the SACND test). At the same time a stationary still camera took pictures every 30seconds of the participant's profile.

The post-intervention base line test (1) was identical to the pre-intervention base line intervention test, conducted in an air temperature of 23°C. To view pilot case findings and discussion, see Appendix 3.

### **3.13.5 Conclusions**

The pilot study suggested that the main hypothesis regarding the ability of RCPWB in water to facilitate improvement of sitting posture and balance was proved to be correct. The functioning of the participant with CP underwent the expected positive change over a period of 19 days. However, due to Moshe's exhaustion in the pilot study, the researcher decided to reduce intensity by increasing total research time in the subsequent study (see Table 6: Moshe versus Manor).

It was concluded that the IRO tool using a still camera to take the pictures was not satisfactory. The camera operation made a noise which produced a reaction by Moshe (a startle reflex). The researcher therefore decided to use a digital camera that would not make noise.

It was concluded that the use of stones to elevate the client in the pilot study was potentially physically harmful for both the participant and the researcher. Therefore a lifting chair should be made in a professional manner without using stones to lift the chair.

It was concluded that a small scale research should take place due to the limitations of size of sample and available finance resources.

It was concluded that the RQ should be more specific as follows:

1. If the sitting position is improved, does this lead to improved ADL functioning in conjunction with hands-head coordination?
2. If sitting position and/or ADL functioning are improved are the perceived competence, self-perception and social acceptance also enhanced?

3. If sitting function, competence and the intrinsic qualities improve, how and why can this improvement enhance the child's QOL?

**Stage 2:** see Table 3

### **3.13.6 The Theoretical Foundations of the Chair (TTC)**

The pilot study was performed to verify the researcher's assumptions that buoyancy and gravitational forces could be used for rehabilitation sitting of children with CP. At that time, the researcher had no idea how to elevate the chair, with the participant, above the water line. However, *'professional experience is another potential source of sensitivity'* (Strauss and Corbin, 1998, p.47), and in this case the researcher used his professional experience and the pilot study to process his assumptions. Stage 2 lasted from July 2003 to March 2004. During this period the researcher invested efforts to generate the resources to fund the design and construction of the treatment chair.

The TTC constituted the innovative technical strategy that created the experimental PIA environment by exploiting the principles of gravity and buoyancy. This tool allowed the researcher to test and actualise the adaptation paradigm of the present study.

**Stage 3:** see Table 3

### **3.13.7 Units of Analysis**

Stage 3 lasted from August 2003 to May 2004. The case study provides explanations for the 'how' and 'why' questions *'because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence'* (Yin, 2003, p.6).

Theory is defined by Strauss and Corbin (1998, p.15) as *'A set of well-developed concepts related through statements of relationship, which together constitute an integrated framework that can be used to explain or predict phenomena'*. The researcher constructed the theory of PIA on the basis of principles reviewed in chapter 2: Theoretical Perspectives that formed the underlying foundation of the study's conceptual framework. The basic assumption of the PIA, asserted that the use of an innovative tool in AT could create facilitating environments, which would allow children with CP to improve their motor adaptation. It was also assumed that this improvement in motor adaptation would trigger adaptation in other psychosocial domains such as the child's PC consequently improving the child's QOL. This theory was tested in the

research. The researcher's criteria for success would be met if these assumptions could be affirmed with the same consistent data results replicated under the same conditions in four case studies (including the pilot), thereby proving the effectiveness of the tested PIA. In relation to the selection of the unit of analysis, Yin (2003, p.23) claims that *'As a general guide, your tentative definition of the unit of analysis (and therefore of the case) is related to the way you have defined your initial research questions'*. [Therefore] *'you must clearly define the unit of analysis at the outset of your study'* (Yin, 1993, p.10; Glaser and Strauss, 1967).

The units of analysis for the present study were:

1. The sitting abilities of the participants with CP, challenged by the PIA intervention;
2. The abilities of the participants with CP to perform functional ADL in conjunction with HHC during independent sitting challenged by the PIA intervention;
3. The PC of the participants with CP, challenged by the PIA and
4. The QOL of the participants with CP, challenged by the PIA.

These units of analysis represented *'Another important aspect of the research question [which] is setting the boundaries on what will be studied.... The research question helps to narrow the problem down to a workable size'* (Strauss and Corbin, 1998, p.40).

### **3.14 The Research Questions (RQ)**

This research addressed four questions:

1. How and why did the posture and balance abilities of participants with CP change during free sitting on land, after the PIA intervention?
2. How and why did the Hand-Head Coordination used in functional Activities of Daily Living (ADL) abilities differ for participants with CP during free sitting on land, after intervention?
3. How and why did the perceived competence of participants with CP vary as a result of the intervention?
4. How and why was the QOL of participants with CP altered as a result of the intervention, and at follow-up one year after intervention?

### 3.15 Definition of the Present Multiple Case Study

*'What is my case?' is the question most frequently posed by those doing case studies'* (Yin, 1993, p.10). The most important part of the case study is the 'case' i.e. the issue(s), problem(s), situation, complexity, and unknowns; defining these components helped the researcher to delimit the research boundaries.

Defining the case enables the researcher to determine the right questions to ask thus, the case definition is: the development of an innovative PIA, constituting the basis for an effective therapeutic intervention, illustrated by the example of improving the sitting skills and consequently the QOL of children with CP.

The issue studied by the case is the adaptation paradigm (using RCPWB) and this constituted the foundation for the conceptual framework of the study (Figure 1).

### 3.16 Study Procedures and Protocol

*'The protocol is a major way of increasing the reliability of case study research and is intended to guide the investigator in carrying out the data collection'* (Yin, 2003, p.67).

The same protocol procedures were used for all the case studies investigated in this study.

The basic and most important parts of the present study protocol (Stage 3) are: the conceptual framework, PIA principles, selection criteria, inclusion/exclusion criteria, data collection, intervention treatments, ethical considerations including those of The JBED regulation, study methods, research tools, treatments and procedures (see Appendices: 1-24 and Research Diary).

#### 3.16.1 Procedures relating to the Participants

*'Also important is obtaining permission from appropriate sources to use those sites'* (Strauss and Corbin, 1998, p.204).

- Letters of permission were obtained from the JBED to enter the two schools chosen for the study).
- A formal conversation was conducted with the school principal introducing the concept of conducting the PhD research project at the school and discussing the candidate participants from the school.

- The researcher obtained an evaluation of the participants' ability to sit freely on a stool from the participant's Physical Therapist.
- Signed letters of informed consent were obtained from the participants' parents (Appendices 11) .
- Permission was obtained to withdraw the pupils from school for their participation in the intervention programme.
- The researcher conducted phone conversations and visits to the participants' parents to discuss and explain the various procedures and conditions within the context of the inquiry.
- All the necessary signed letters of consent were obtained from the schools, authorities etc.

### **3.16.2 Developing the RSADLOT**

One of the objectives at Stage 3 of the research was to develop a tool to measure the sitting abilities of the children with CP during performance of ADL functions, in order to determine whether enhanced sitting performance improves basic functioning.

The RSADLOT, performed during free sitting, was developed and used in Stage 4 of the research. For the process involved in the test's development and problematic issues affecting its design, see Researcher's Diary (15<sup>th</sup> August, 2003, 23<sup>rd</sup> September, 2003, 21<sup>st</sup> January, 2004).

**Stage 4:** see Table 3

### **3.16.3 Case Study Design: The Issue involved**

Stage 4 lasted from May 2004 to December 2004. *'Issues draw us toward observing, even teasing out, the problems of the case, the conflictual outpourings, the complex backgrounds of human concern'* (Stake, 1995, p.17). The 'issue' at stage 4, was the effect of combined water and land intervention.



**Aim - Manor and Avi 's case:** To match identically characteristics of both participants  
**Objectives:** Applying the Formula 'A/B/A/C/A/D/A' design.

*These designs vary according to whether...or not multiple baselines are used, whether or not multiple measures of different problems or outcomes are incorporated, and whether single, multiple, or changing-intensity treatments are incorporated and assessed (Bloom and Fischer, 1982 in Anastas and MacDonald 1994, p.202).*

Both participants are from the same school ('Hadar'), and from the same cultural and economic backgrounds. Both of them joined the study after the inclusion and selection criteria had been established. Using *'two groups [or two individuals] of students who were very closely matched on significant characteristics (e.g. age, gender, ability etc.---whatever characteristics are deemed to have a significant bearing, on the responses), then similar results (on a test) or responses (to a questionnaire) would be obtained'* (Cohen at al., 2000. p.118).

Both participants, were selected by controlling extrinsic factors - prior to the research (Scherzer and Tscharnuter, 1990; Nachmias and Nachmias, 1996; Riegelman and Hirsch, 1996; Depoy and Gitlin, 1998, see, Table 4).

Table 3: Stage 4 included two types of environmental intervention: first, an AT exercise treatment programme with introduction to PIA treatments (Tables 6 and 7), second, the application of the intervention for the same participant, increasing the ability to sit and function by stimulating sitting without support on land on a daily basis (see Diary. 5<sup>th</sup> March, 2005).

See also Appendix 21: Stimulation to the Edge of Balance Intervention with 2 examples.

**Aim of Maor's case:** To achieve ADLSF (see entries in Researcher's Diary. 2<sup>nd</sup>, 6<sup>th</sup>, 7<sup>th</sup> June, 2005).

**Objectives:** construction of case study design; ADLSF; case intervention.

### Case Study Design

Maor's treatment extended from March 2005 to August 2005. The participant is from 'Tamar' school, his cultural and economic background resembled that of the participants in Stage 4. Maor joined the study after satisfying the inclusion and selection criteria of the study procedures and protocol (established in Stage 3 of the study).

### The Issue Involved

*Issues are problems about which people disagree, complicated problems within situations and contexts ... Choosing issues helps us define data sources and data-gathering activities* (Stake, 1995, p.133).

Maor's case related to the issue of performance of ADLSF in conjunction with HHC (for further background issues relating to ADLSF see Appendix 20). The issue in Maor's case was to improve the child's sitting performance applying the PIA with SPT base treatment (in addition Maor also practiced ADLSF treatment which aimed to improve functional adaptation), while ADL were facilitated by the environments developed by the TTC. Both treatment strategies were combined for Maor, by providing the different strategies in alternate sessions. This was an improved strategy for the intervention's treatment arsenal, better than the strategy presented earlier which only provided SPT.

*The Bobaths have repeatedly stressed that function must be the primary treatment goal in NDT without neglecting the role automatic postural mechanisms play in regard to the efficiency of function'* (Scherzer and Tscharnuter, 1990, p.296, Koury, 1996, Howle, 2004).

**Aim of Keshet's case:** To test an intervention consisting of PIA applied in water followed by land treatment (see Researcher's Diary: 21<sup>st</sup>, 23<sup>rd</sup> November, 2005, 2<sup>nd</sup> January, 2006).

**Objectives:** Testing potential of water-land sitting treatments to benefit the child's quality of sitting.

### Case Study Design

Keshet underwent treatment from September 2005 to February 2006. This female participant of the study was from 'Tamar' school, and her cultural and economic backgrounds resembled those of the participants in stage 4 of the study. Keshet joined the study after demonstrating compatibility with the study's inclusion and selection criteria.

### The Issue in Keshet's Case

Keshet's intervention consisted of an examination of the benefits of the PIA treatments for the land intervention treatments. The combination of water and land treatment interventions was considered as having the potential to enhance the quality of sitting for the child with CP (Keshet). This case was '*chosen because it is believed that understanding [it]...will lead to better understanding, perhaps better theorising about a still larger collection of cases*' (Stake, 2000, p.437),

through the use of inductive thinking (see Appendix 20: Headers: Choosing Keshet's Case ... and Keshet's Intervention Process).

### 3.17 Validity, Reliability and Credibility

The strategy chosen for the inquiry process was an MMD with holistic multiple case studies. It employed the advantages of '*data triangulation*' (Patton, 1987; Stake, 1995) between different methods and data and used a pilot study to develop a treatment tool-TTC, manipulating and analysing 4 replication cases (Yin, 2003), using NDFI for comparative analysis (Strauss and Corbin, 1998; Morse and Niehaus, 2009) between and across cases, to test and ultimately derive conclusions concerning the effects of an innovative PIA.

The study extracted both quantitative and qualitative data (Yin, 1993, 2003). The data were tested for validity, reliability and credibility (Guba, 1981; LeCompte and Gietz, 1982; Miles and Huberman 1984), using several sources of evidence. In order to establish a chain of evidence, variables of time and place, 8 tools were used to enable a variety of triangulations to increase the study's constructive and internal validity and reliability (Yin, 1984; Strauss and Corbin, 1998; Merriam, 1998; Denzin, 1970 in Cohen et al., 2000; Patton, 2002). Cohen et al. (2000, p.110) explain that '*this can be achieved through correlations with other measures*'.

Validity and reliability are the 'key' to establishing any type of contribution to research. What is the relationship between these two words? Cohen et al. (2000, p.105) answer:

*It is suggested that reliability is a necessary but insufficient condition for validity in research; reliability is a necessary precondition of validity....Validity is an important key to effective research. If a piece of research is invalid then it is worthless.*

Thus, one may suggest that '*both qualitative and quantitative methods can address internal and external validity*' (Cohen et al., 2000, p.107). Potential external validity was reinforced by replication logic using multiple case study (Merriam, 1998; Cohen et al., 2000; Yin, 1984; 2003).

The extent of contribution of the present research can be assessed and validated according to the view of Yin (1993, p.59, Merriam, 1995; 1998; Patton, 2002), that '*the case study is to be used as any other empirical, scientific method [strategy]. The rigor of case studies should therefore be judged by the same criteria of internal validity, external validity, construct validity, and reliability*'.

Equivalent concepts suggested in the context of the inductive naturalistic view, for the establishment of a research's 'rigor' by Lincoln and Guba (1985); Hammersley (1992); Denzin and Lincoln (2003, p.35) and Shkedi (2005) are '*terms such as credibility, transferability, dependability,*

*and confirmability'* while Merriam (1995; 1998), the U.S. General Accounting Office (1990 in Yin, 2003), Morse (2006a), Lofqvist et al. (2008); and Stamm et al. (2008), add the concept of *'trustworthiness'*.

Table 12 below details the processes used in the present study to validate the findings.

**Table 12: The Inquiry Validation Process**

Stages, Dates, Design	Tool used to withdraw data	Data Collection Techniques persons involved and space	Type of data analysis used	Type of data produced	Between methods and two data Triangulation
<b>Stage 1</b> 12 <sup>th</sup> April 2002 <b>Moshe</b> (Pilot)  A/B/A	<b>Interview:</b> Informal conversational Interview	Diary; professionals at work place	Knowledge analysed	Ideas	Comparing data within cases and methods, and across cases
	Non-Directive Focused Interview (NDFI)	Personal; child with CP, mother, both taped	Post-compared to pre -with defined categories	Propositions	
	<b>Goniometry</b>	Protocol techniques	Post minus pre	Numbers	
	<b>Observation:</b> Rating scales: SACND	Personal; video and protocol techniques	Picture comparison	Numbers	
	Interval recording IRO	Digital pictures: 30 seconds intervals	Picture comparison	Numbers	
<b>Stage 2</b> 8 <sup>th</sup> July, 2003  Developing the Treatmeant Chair	<b>Interview:</b> Informal conversation interview in person	Diary; professionals At work place; telephone conversations	Self experience and field analysis	Ideas	Using Quantitative and Qualitative data to test the PIA
	<b>Combination, synthesis and integration</b> of principles and techniques from different sources.	Literature: Bax (1964, p.295) CP definition 'disorder of movement and posture'.	CP interviews, field and experience analysis	Propositions	
<b>Stage 3</b> August, 2003 developing the study Design	<b>Interview:</b> Informal conversation interviews in person.	Researcher's Diary; professional at work place; using telephone.	Knowledge analysed	Ideas	Using Quantitative and Qualitative data to test the PIA.

Stages, Dates, Design	Tool used to withdraw data	Data Collection Techniques persons involved and space	Type of data analysis used	Type of data produced	Between methods and two data Triangulation
<b>Stage 4</b> 5 <sup>th</sup> May, 2004  <b>Manor= r</b> <b>Avi = c</b> A/B/A/C/A/D/A  <b>Maor</b> 30 <sup>th</sup> March, 2005 A/B/A/C/A/D/A  <b>Keshet</b> 12 <sup>th</sup> September, 2005 A/B/A/C/A/D/A Each case Stages replicated	<b>Reading Literature</b> sources	Books and articles	Information analysed	Propositions	Comparison within internal cases and methods, and across the cases, using quantitative and qualitative data to test the PIA
	<b>Interview:</b> NDFI	Personal; child with CP, parents school staff , all taped	Post- intervention status compared to pre-intervention status with category	Propositions	
	<b>Goniometry</b>	Personal; protocol techniques	Post minus pre	Numbers	
	<b>Observation:</b> Rating scales: SACND	Personal; video and protocol techniques	Picture comparison	Numbers	
	RSADLOT	Personal; protocol techniques	Post- intervention minus pre-intervention status	Numbers	
	Interval recording IRO	Digital pictures: 30 seconds intervals	Picture comparison	Numbers	
	<b>Questionnaires:</b> Rating scales, Pictorial Scale of Perceived Competence in Israeli Children with CP (PSPCICCP)	Personal; protocol techniques	Post- intervention minus pre- intervention status	Numbers	
	Rating scales = Likert Scale, GMFM	Personal; protocol techniques	Post-data status compared to pre-data status	Numbers	
	Ordinal scale GMFCS	Personal; protocol techniques	Pre-treatment baseline for Inclusion and selection criteria	Propositions and Numbers	

### 3.17.1 Internal Validity

A scholarly debate asks: *'Is reality fixed and stable as the positivists believe, or constructed and interpreted as qualitative researchers believe?'* (Merriam, 1995, p.53). Establishing internal validity within a positivistic paradigm was defined by Yin (2003, p.34) as *'establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships'*. Internal validity of a naturalistic paradigm means discovering whether the research is *'sustained by the data'*, (Cohen et al., 2000, p.107), and whether the findings of the study fit the studied issues or its meaning, which is constructed, multidimensional, ever-changing and holistic (Merriam, 1995; 1998; Wisker, 2008).

The invented PIA treatment intervention with 'TTC enabled children with CP to improve: duration of their independent-free sitting, sitting posture, performance of ADL functions in conjunction with HHC, perceived competence and their QOL. These events were based on a causal relationship where event X led to event Y (Merriam, 1998; Yin, 1984, 2003). This principle 'X led to Y' was implemented as follows: uniformity of conditions was ensured for all cases following the same conceptual framework (Illustration 1) participants were selected according to identical selection criteria, introducing the PIA with 'TTC, with a basic SPT intervention for all participants, the same methods and research tools were applied to all. This ensured effective replication of the causal relationship and reinforced the internal validity of the research.

### 3.17.2 Improving Validity and in particular, Internal Validity

Mixing methods (Campbell and Fisk, 1959), maximises objectivity, accuracy, and adequacy of analysis, while reducing bias and factual errors. To reinforce the validity of the inquiry, the researcher took the following steps: piloting improved the construction of the RQ, refined the data collection and gave a trial basis for the investigator in a 'laboratory' role, adapting the RQ and techniques to the field (Knight, 2002; Yin, 1984; 1993; 2003). Units of analysis were specified for the inquiry, using multiple sources of evidence, and providing a chain of evidence to improve the construct validity of the study (Yin, 1993, 2003). NDFI were conducted with five human units associated with the child with CP (the child, parents, Physical Therapist and/or Conductor, Conductor Assistant, Teacher, Teacher's Assistant and caregiver). This enabled the gathering of a total of 44 NDFI, whose analysed data were employed for triangulation with quantitative findings and thus helped to reinforce validation (Stake, 1995, 2000).

This pattern of data-collection was used systematically in pre-and post-intervention evaluations. To prevent bias and increase objectivity, the goniometer scale was covered with opaque adhesive paper. The researcher performed the treatment intervention and the first assistant had sole responsibility for the measuring. Several examples regarding the improvement of validity/reliability and objectivity are described in the literature on research tools used in this study are: goniometry (Boone et al., 1978; Riddle et al., 1987; Clarkson, 2000), observation of rating scales-SACND (Reid, 1997), IRO-inter-rater (judge) reliability (Guilford and Fruchter, 1973; Shrout and Fleiss, 1979; Cohen et al., 2000), GMFM (Russell et al., 1993), GMFCS (Palisano et al., 1997) and PSPCICCP (Schneider, 1996).

The inquiry applied the recommendations of Yin (2003) and Shkedi (2005) for the improvement of internal validity, so that the researcher provided explanation-building with the help of a literature review, and developed units of analysis which led to the RQ. Another strategy that enabled the researcher to broaden the study concept and thus to benefit validity and better application (Morse, 2006a), is to link concepts with the application of the same or other concepts: e.g. the 'Carry Over Principle' (Morris, 1997; 2004). During the analysis process the researcher formed replication logic to test the PIA and compared the supplementary emergent NDFI data with categories derived from NDFI gathered at different base lines (Table 8: A1 to A3 to A4) in order to improve the validity of his interpretations, explanations and conclusions regarding the total phenomenon of participant's QOL (Morse and Niehaus, 2009).

### 3.17.3 External Validity

Within a naturalistic research paradigm, external validity is '*interpreted as comparability and transferability*' (Lincoln and Guba, 1985; Eisenhart and Howe, 1992, p.647 in Cohen et al., 2000, p.109).

A case study should be understandable and usable, and translatable to other contexts (Wisker, 2008). Two strategies are applicable in order to examine the current research findings' potential for generalisation:

First, are processes that Stake (2000, p.442) called naturalistic generalisation '*case study researchers assist readers in the construction of knowledge*'. Firestone (1993, p.22), called it '*case-to case translation [or transfer] ... for application from the researcher to the reader*', Morse (2007, p.148), called it '*development of meaning ... in other places ... groups and in other situation*', while Corbin (2009) indicated that '*readers ... construct their own interpretations of findings [and decide for themselves if there is something to]... gain from them*' (p.40). The researcher provided rich information throughout the thesis concerning the research process and findings which



readers may use to construct their own meaning from the findings and to decide whether the findings are transferable to their own phenomena (Knight, 2002; Wisker, 2008).

The second strategy that can be applied to the present study was suggested by Shkedi, (2003; 2005) and Yin (1984)

*'In analytical generalisation, the investigator is striving to generalise a particular set of results to some broader theory' (p.39).*

Yet, it should be noted that *'to generalise to a theory is to provide evidence that supports (but does not definitively prove) that theory'* (Firestone, 1993, p.17). Replication logic was applied in the multiple case studies of the present research as one way to verify the effectiveness of the PIA. The approach was tested/validated through replication comparison to improve conclusions and widen applications (Firestone, 1993). Thus, *'The use of theory ... becomes the main vehicle for generalising the results of the case study'* (Yin, 2003, p.33).

#### **3.17.4 Construct Validity**

Construct validity is defined by Yin (2003, p.34) as *'establishing correct operational measures for the concepts being studied'*. To establish this validity, the present research used eight tools to provide multiple sources of evidence in a process of triangulation; a case study protocol and database based on the study's Appendices and the Researcher's Diary; forming factual evidence and a two-way research procedure that was able to create and *'maintain a chain of evidence'* (Yin, 2003, p.105), enabling the reader to trace the links from RQ, to data and to interpreted conclusions, and allowing conclusions to be traced back to the RQ (Yin, 1984; 1993; 2003; Shkedi; 2005; Wisker, 2008).

Denzin (1970) in Cohen et al. (2000, p.114) , *' identifies two categories in his typology: 'within methods' triangulation and 'between methods' triangulation.* Thus, both strategies: 'within' methods (the replication enhanced PIA reliability and confirmation) and 'between' methods (uses two or more methods-tools to examine a single phenomenon of e.g. a sitting child using PIA) triangulation enhanced validity and reliability.

#### **3.17.5 Reliability**

Naturalistic reliability is defined by Cohen et al. (2000), who suggests that:

*Reliability includes fidelity to real life, context and situation-specificity, authenticity, comprehensiveness, detail, honesty, depth of response and meaningfulness to the respondents (p.120).*

Positivist reliability exists according to Yin (2003) when *'operations of a study-such as the data collection procedures-can be repeated, with the same results'* (p.34). In order to achieve such reliability,

it is possible to replicate the case study condition, reducing errors and biases, while not necessarily replicating the results of the study, but rather the process of operations (Yin, 1984; Firestone, 1993; Yin, 2003; Shkedi, 2005; Wisker, 2008). Thus, the present study conducted identical processes for each participant (excluding parts which were not included in the pilot case).

All participants received the same tools evaluation: PIA with SPT intervention in water and land environment. The difference was the 'play' between distribution of amounts of intervention between water and land environments and adding ADLSF treatment alternation to Maor and Keshet. These diverse 'dosages' were carried out purposely to construct the best possible treatment and adapt the treatment to individual abilities, needs and development. *'No two cerebral palsy children are alike and therefore each cerebral palsy child needs different treatment and different exercises'* said Bobath (1974, p.35), suggesting the complexity of the CP phenomenon (McNeill, 2004 Gage, 2004 in Gorton et al., 2009). These points are discussed in Chapters 1: Introduction, Research Problems, and 5: Discussion, 5.6 Critique.

### **3.17.6 Improving Reliability**

The present research improved its eventual reliability (Yin, 1984; 1993) by piloting (stage 1). The research protocols, appendices, diary and procedures of the multiple cases including study selection criteria, data collection and intervention treatments, all increased the study's reliability (Yin, 1984; 1993; 2003). The researcher used three independent observers in an inter-rater reliability strategy (Guilford and Fruchter, 1973; Shrout and Fleiss, 1979; Cohen et al., 2000) during IRO (Stages 1 and 4 of the inquiry) which increased data reliability (Yin, 1984; Knight, 2002). Yin (2003) indicates that developing a *'protocol is an especially effective way of dealing with the overall problem of increasing the reliability of case studies'* (p.57) allowing others to review the research procedures and results (Yin, 1984; 1993; 2003; Shkedi, 2005).

According to Yin (2003); Morse and Niehaus (2009) a pilot study *'instrument can become more reliable through training and practice'* (Merriam, 1998, p.206). The researcher trained himself to operate the goniometer for the specific needs of the present research (Appendix 13) and also used tools with a test-retest reliability (Cohen et al., 2000; Knight, 2002) as was described previously when relating to validity of tools.

### 3.18 Presentation of Findings

The findings of the present inquiry are presented chronologically in the next chapter relating to the relevant issues as they appeared in the chapters of this thesis, according to the four RQ and the relationships between them. The findings are presented in numerous formats, including quotations, descriptions, tables and graphs, providing a strong visual and written illustration of the conjunction of information, and establishing a holistic presentation of the phenomena. Although the present research findings have their limitations, they illustrate the broad potentialities of the proposed PIA and its uniqueness.

### 3.19 Ethical Considerations

*'Good research ... requires ethical approval'* (ARU Research Student Handbook, 2009-2010, p.79). The present inquiry complied with all the requirements described in the Anglia Polytechnic University Ethical Guidelines (2004-2005, Section 4, pp.47-65). It also used the research and practice procedures, protocol and guidelines mandated by the JBED (Diary: 26<sup>th</sup> August, 2002 and; Diary: 20<sup>th</sup> June, 2003).

During and at the conclusion of the research, the researcher dealt with all relevant ethical considerations in a strict manner. Specific points particularly adhered to:

1. All participants were given full anonymity which included names of the participants, their family, friends, schools, homes or other locations used in the study.
2. All names and places which might identify the participant are therefore fictitious to maintain confidentiality.
3. All participants' pictures were presented in such a way that they cannot be identified. This was done by whiting out all participants' heads to ensure non-identification.
4. The procedures and objectives were explained in full to all participants and their families, as well as the consequences of the sitting treatments, possible harm and risks if any, and the general research process and goals were described. A letter of consent was written and signed by the family. Requisite procedures of participant selection were followed, assisted by the school principal's guidelines in order to ensure respect and confidentiality. Privacy was maintained when handling the participant when changing clothes, bathing, using the toilet and in relation to other personal issues.

### 3.19.1 The Researcher's Role in the Inquiry

The present inquiry involved the researcher's interaction with many professionals involved with the CP participant. These included the district supervisor and the inspector representing the JBED and the Jerusalem municipality; therapists, teachers, teacher assistants, school staff-management at the school level and the closer circle associated with the participant.

Knight (2002) mentioned the significance of family members' involvement in the research in his book. Similarly, in the present study the family constituted an important source of support and data. The present researcher's role, as can be seen, involved dealing with a wide variety of professionals across the participant's community.

The main starting point was *'How do we 'get in'? That, of course, varies according to the group one is attempting to study'* (Denzin and Lincoln, 2003, p.76). Several problematic issues that should concern the researcher, are noted by Cohen et al. (2000) and Patton (2002): as mentioned, the entry-accessibility to the school-organisation; negotiation with principals-managers; establishment of rules and conditions for the role of the researcher; perspective and interests of the relevant authorities in the inquiry; and the need to develop acceptance, trust and rapport. Thus, the researcher needed to establish goodwill and co-operation, solve problems of a practical kind, and constantly keep ethical considerations in mind with respect to the research, the participants and the organisation.

The researcher's position during the present inquiry was as noted by Cohen et al. (2000) *'When a researcher is normally a member of the organisation where the research is taking place [he is considered] an insider'* (p.54).

## 3.20 Chapter Summary

This chapter explained the reasons for the choice of the research methodology, and described the methods and tools adopted. It focused on the study's limitation with regard to external validity but indicated how the researcher improved internal validity and consequently reliability by employing various types of triangulation using MMD with multiple case study strategy. Data analysis and interpretation was performed using strategies from both viewpoints: quantitative-replication logic and comparison with qualitative-NDFI.

The new chapter presents the quantitative findings followed by the corroborating qualitative findings according to each of the four RQ.

## CHAPTER 4: FINDINGS

### *Precis*

In the last chapter, the researcher explained how an MMD was employed for this study, using a multiple case study strategy and triangulation to increase the study's validity and reliability. The present chapter presents the data collected with the various different tools according to the order of the RQ, describing the quantitative and qualitative findings for each question as they relate to each of the studied cases. Table 11, Chapter 3: Methodology summarises all findings according to the four RQ.

### **4.1 Research Findings Pertaining to Improvement of Independent Free Sitting on a Flat Stool on Land (RQ 1)**

Tables 10 (relating to RQ 1, p. X) and 13 below, show the different tools employed in the different triangulations to reinforce the data. Data triangulation was performed between quantitative numerical data and qualitative descriptive data. Investigator triangulation was also conducted as the same phenomenon yielded positive findings from two observation tools SACND and IRO. 'Between methods' triangulation was conducted between data from three quantitative tools (incorporating time triangulation) and qualitative data from NDFI between pre-post intervention. Both types of data were used to evaluate the at rest sitting posture and balance of participants.

**Table 13:**

**Type of Tool and Data collected to answer Research Question 1**

Research Question 1	Quantitative Research Tools	Qualitative Research Tools
How and why did the posture and balance abilities of the participants with CP change during free sitting on land, after the PIA intervention?	<ol style="list-style-type: none"><li>1. Universal goniometer, a device for measuring joint angles or ROM.</li><li>2. Rating scales observation: the SACND. The rest module evaluates abilities to sit at rest.</li><li>3. Interval Recording Observation (IRO).</li></ol>	<ol style="list-style-type: none"><li>1. Non-directive focused Interview (NDFI)</li></ol>

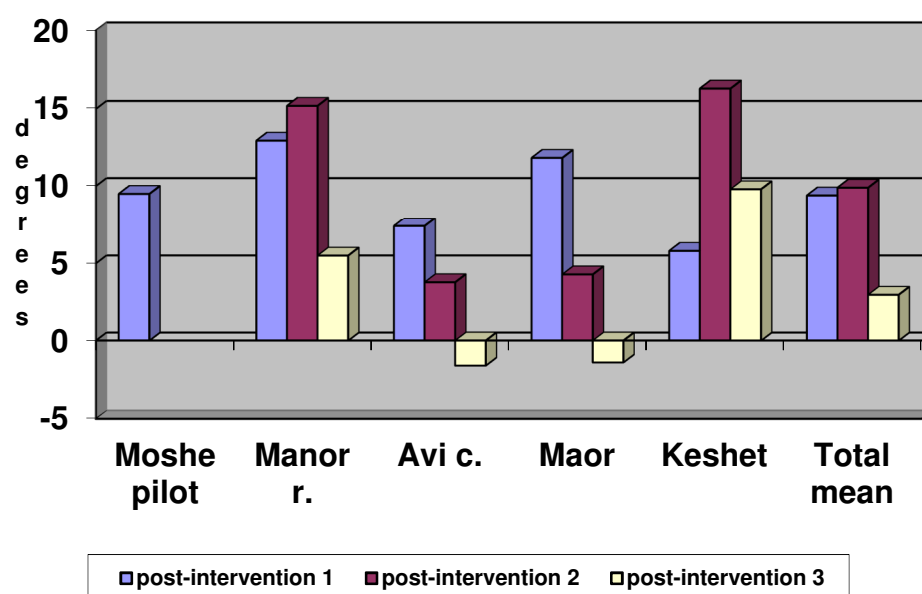
#### 4.1.1 Improved free sitting according to the quantitative tools

##### Quantitative Findings Pertaining to the Participants' Improved Sitting from ROM Tests relating to Hip Flexion.

Each research participant received therapeutic intervention tailored for their needs according to the research plan, (Table 6 and 7). Graph 1 below shows the mean differences in results relating to hip flexion measured by mixed passive and active Goniometric Tests for all participants between pre-intervention and three post-intervention tests.

**Explanation for all Graphs in this Chapter:**

**Graph 1:**  
**Mean Difference in Goniometric Measurements (degrees) of Hip Flexion**  
**at the different Pre-Post intervention tests,**  
**each Participant representing different amounts of Treatments in different**  
**Treatment Environments**  
R - Research c – Control



The reader is reminded that the three tests (post-intervention, 1, 2 and 3) whose results are presented in the above graph related to the following treatments:

- Post-intervention test 1 (blue columns) relates to effect of PIA water treatment with the following lengths of treatment (in minutes): Moshe-720, Manor-1200, Avi-0, Maor-1440 and Keshet-960.
- Post-intervention test 2 (brown columns) relates to effect of PIA water and land treatment with the following amounts of treatment (in minutes): Manor-2020, Avi-820 (land), Maor-2640 and Keshet-2580.
- Post-intervention test 3 (yellow columns) relates to effect of land treatment with the

following amounts of treatment (in minutes): Manor-820, Avi-820, Maor-1200 and Keshet-1620.

- Moshe Manor and Avi received Strength Posture of the Trunk (SPT) and Manor and Keset received SPT alternated with Activities of Daily Living with Skills Function (ADLSF) treatment.
- Moshe (pilot case) is not included in the calculation of the total mean in the above graph.

Analysis of Graph 1, indicated an impressive improvement during independent sitting of the participants, as described below: All the research evaluations/ measurements were conducted on land.

**Moshe**-(Pilot): Post-intervention test 1: PIA water treatment, showed a large improvement expressed by an increase in ROM in flexion of both hips. The PIA water treatment improved the quality of at rest free sitting.

**Manor**-Research (r): Post-intervention test 1: PIA water treatment, showed a large increase in ROM in flexion of both hips which improved quality and balance of at rest free sitting. Post-intervention test 2: PIA water and land treatments, showed improved sitting quality and balance for Manor more than appeared at post-intervention test 1. Post-intervention test 3: showed that land treatment was less beneficial for quality and balance of free sitting in comparison with treatments 1 and 2.

**Avi** - Control (c): Post-intervention test 1: PIA water treatment. Avi received no water treatment but underwent the same evaluation as Manor on land. Some insignificant improvement was evident during evaluation of ROM in flexion of both hips. (It is suggested that this improvement might have appeared due to other variables which affected the evaluation results, this finding is discussed later in Chapter 4: Graph 4: a description of **Avi-Control (c)**, and in Chapter 5: 5.2.2, Head line: **Avi Control Participant**).

Post-intervention test 2 for Avi related to water and land treatment without PIA water treatment. Some improvement was visible following land treatment. Post-intervention test 3: related to land treatment, and produced a negative result and did not show improvement in free sitting quality and balance.

**Maor** - Post-intervention test 1: PIA water treatment, showed a large increase in ROM in flexion of both hips, which improved quality and balance of at rest free sitting. Post-intervention test 2: PIA water and land treatments, resulted in less improvement for Maor's sitting quality and balance compared to results of post-intervention test 1: PIA water

treatment. Post-intervention test 3: land treatment produced negative results and was shown to be less beneficial to free sitting quality and balance than treatments 1 and 2.

**Keshet** - Post-intervention test 1: PIA water treatment, showed an increase in ROM in flexion of both hips, which improved the quality and balance of Keshet's at rest free sitting.

Post-intervention test 2: PIA water and land treatments, resulted in a greater improvement in sitting quality and balance than found in post-intervention test 1 and 3. Post-intervention test 3 showed that land treatment produced greater improvement than water- examined in test 1 and less improvement than appeared in test 2. The difference in levels of effectiveness for the different treatment environments is illustrated in Table 14 below.

**Table 14:**

**Effectiveness of Intervention in different Environments:  
Input - Participants' Treatment Time (in minutes)  
Output - Amount of Improvement (in degrees)**

Environment	Manor		Avi		Maor		Keshet		Total mean	
	Min	Deg	Min	Deg	Min	Deg	Min	Deg	Min	Deg
<b>Water</b>	1200	13	0	7.5	1440	12	960	6	900	9.6
<b>Water + Land</b>	2020	15	820	4	2640	4	2580	16	2015	9.7
<b>Land</b>	820	6	820	-2	1200	-2	1620	10	1115	3

**Min=minutes; Deg=Degrees**

The total mean result for PIA water treatment (900 minutes per improvement of 9.6 degrees) was more effective in proportion to the amount of treatment, compared to results at post-intervention test 2: for PIA water and land treatments (2015 minutes per improvement of 9.7 degrees), and post-intervention test 3: for land treatment (1115 minutes per improvement of 3 degrees).

### ***Summary of Goniometric Findings***

Analysis of the three intervention treatments-1, 2 and 3-seems to suggest the following:

According to Graph 1, all participants showed a large increase in ROM in flexion of both hips, which improved quality and balance of at rest free sitting.

### **Efficiency of intervention:**

Post-intervention test 1: Showed that PIA water treatment, produced better results in proportion to the amount of treatment compared to other treatments.



### Highest results of intervention:

Post-intervention test 2: PIA water and land treatment was the longest intervention with the greatest contribution to free sitting quality and balance.

### Lowest results of intervention:

Post-intervention test 3: Land treatment alone produced the lowest results and was least beneficial to free sitting quality and balance in comparison with treatments 1 and 2.

### Conclusion

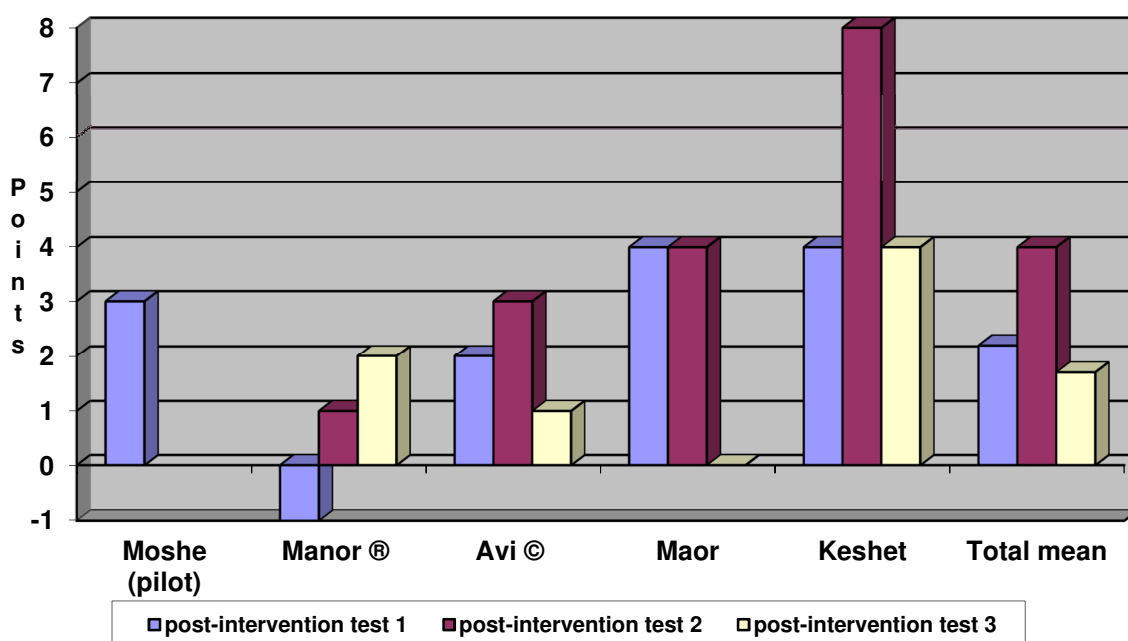
Reid (1997, p.4) defined SACND balance as the operational ability to move body weight and return to previous midline position without any support - this would be considered a significant improvement, indicated by increased hips flexion-ROM for participants in the context of improved free sitting quality and balance.

### Quantitative Findings Pertaining to Improved Sitting of the Participants from SACND at Rest Module Tests

Graph 2 below shows differences in sitting posture found in results for the at rest module for all participants between pre-intervention and three post-intervention evaluations.

**Graph 2:**  
**Differences in Sitting Posture measured according to to Judged SACND Rest**  
**Module Evaluation (in points) between Pre-Post intervention tests,**  
**each Participant representing different amounts of Treatments in different**  
**Treatment Environments**

R - Research c - Control



The reader is reminded that the three tests (post-intervention, 1, 2 and 3) whose results are presented in the above graph related to the following treatments:

- Post-intervention test 1 (blue columns) relates to effect of PIA water treatment with the following lengths of treatment (in minutes): Moshe-720, Manor-1200, Avi-0, Maor-1440 and Keshet-960.
- Post-intervention test 2 (brown columns) relates to effect of PIA water and land treatment with the following amounts of treatment (in minutes): Manor-2020, Avi-820 (land), Maor-2640 and Keshet-2580.
- Post-intervention test 3 (yellow columns) relates to effect of land treatment with the following amounts of treatment (in minutes): Manor-820, Avi-820, Maor-1200 and Keshet-1620.
- Moshe Manor and Avi received Strength Posture of the Trunk (SPT) and Manor and Keshet received SPT alternated with Activities of Daily Living with Skills Function (ADLSF) treatment.
- Moshe (pilot case) is not included in the calculation of the total mean in the above graph.

For further information see Tables 6 and 7, pp.98 and 99.

Analysis of data, presented in Graph 2, indicated a large improvement in quality of independent sitting for the following participants:

**Moshe - (Pilot):** Post-intervention test 1: PIA water treatment, showed a large improvement relating to quality of rest during at rest free sitting.

**Manor - Research (r):** Post-intervention test 1: PIA water treatment, showed a negative result. PIA water treatment did not improve the quality of at rest free sitting. Post-intervention test 2: PIA water and land treatments improved the quality of Manor's sitting and balance, compared to the results of treatment at post-intervention test 1.

Post-intervention test 3: land treatment, showed a greater improvement in quality of sitting and balance than was evident in post-interventions tests 1 and 2.

**Avi - Control (c):** Post-intervention test 1: PIA water treatment. Avi received no water treatment. Some improvement was evident (suggesting that there may be other reasons for this improvement outside the researcher's control). Post-intervention test 2, there was no PIA water treatment, but there were land treatments, which improved the sitting quality and balance more than was evident at post-intervention test 1 without PIA water, which Avi did

not receive. Post-intervention test 3 showed that land treatment, was less beneficial for free sitting quality and balance than treatments 1 (that Avi had not received) and 2.

**Maor** - Post-intervention test 1: PIA water treatment, showed a large improvement in quality of rest during at rest free sitting. Post-intervention test 2: PIA water and land treatments, improved sitting quality and balance as much as was evident at post-intervention test 1 following PIA water treatments. Post-intervention test 3 showed that land treatment alone did not contribute to the improved quality of independent at rest sitting and balance, when compared to results at post-intervention test 1 and 2.

**Keshet** - Post-intervention test 1: PIA water treatment, showed improvement in quality of rest during at rest free independent sitting. Post-intervention test 2: demonstrated that PIA water and land treatments, improved sitting quality and balance more than was evident at post-intervention test following water treatment 1. Post-intervention test 3: showed that land treatment alone, produced a lower contribution to at rest sitting and balance compared to post-intervention test 1 and 2 results. The difference in levels of effectiveness for the different treatment environments is illustrated in Table 15 below.

**Table 15:**  
**Effectiveness of Intervention in different Environments measured**  
**by SACND Rest Module:**  
**Input - Participants' Treatment Time (in minutes)**  
**Output - Amount of Improvement (in points)**

Environment	Manor		Avi		Maor		Keshet		Total mean	
	Min	Points	Min	Points	Min	Points	Min	Points	Min	Points
Water	1200	-1	0	2	1440	4	960	4	900	2.2
Water + Land	2020	1	820	3	2640	4	2580	8	2015	4
Land	820	2	820	1	1200	0	1620	4	1115	1.7

**Min=minutes**

Total mean for PIA water treatment (900 minutes per 2.2 points) indicated that this treatment produced better results in proportion to the amount of treatment, compared to results at post-intervention test 2: for PIA water and land (2015 minutes per 4 points), and results at post-intervention test 3: for land treatment (1115 minutes per 1.7 points).

### ***Summary of Findings from SACND Rest Module***

The results of the three post-intervention tests relating to the three types of treatments- 1, 2 and 3- shown in Graph 2, suggest the following: all participants showed a great improvement in quality of rest during at rest free sitting and balance.

#### **Efficiency of intervention:**

Post-intervention test 1: showed that PIA water treatment produced better results in proportion to the amount of treatment, when compared to other treatments. This was demonstrated in a comparison of SACND at rest module test measurements (in points) following treatment in different types of environment and with different amounts of treatment (in minutes) -(see Graph 2).

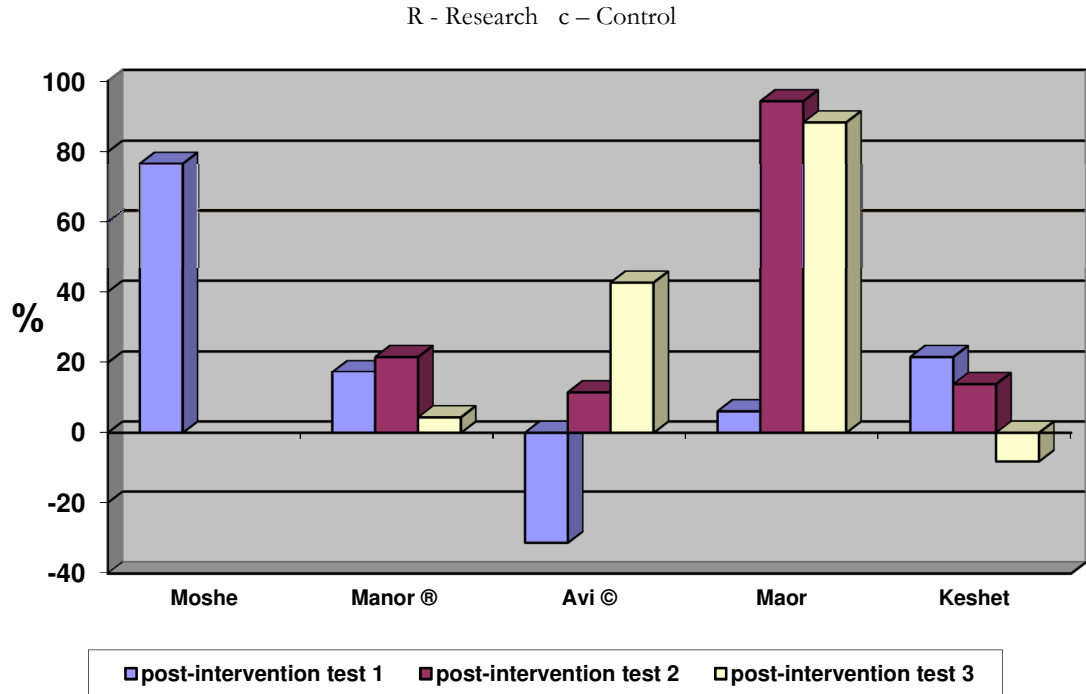
#### **Highest results of intervention:**

Post-intervention test 2: Indicated that PIA water and land treatment was the longest intervention with the highest contribution to free sitting quality and balance.

#### **Lowest results of intervention:**

Post-intervention test 3: Showed that land treatment alone produced the lowest results and was less beneficial for free sitting quality and balance than treatments 1 and 2.

**Graph 3:**  
**Differences in Sitting Posture based on Inter-Raters Evaluation of Pictures (in mean percentages) between Pre-Post intervention tests, each Participant representing different amounts of Treatments in different Treatment Environments**



The reader is reminded that the three tests (post-intervention, 1, 2 and 3) whose results are presented in the above graph related to the following treatments:

- Post-intervention test 1 (blue columns) relates to effect of PIA water treatment with the following lengths of treatment (in minutes): Moshe-720, Manor-1200, Avi-0, Maor-1440 and Keshet-960.
- Post-intervention test 2 (brown columns) relates to effect of PIA water and land treatment with the following amounts of treatment (in minutes): Manor-2020, Avi-820 (land), Maor-2640 and Keshet-2580.
- Post-intervention test 3 (yellow columns) relates to effect of land treatment with the following amounts of treatment (in minutes): Manor-820, Avi-820, Maor-1200 and Keshet-1620.
- Moshe Manor and Avi received Strength Posture of the Trunk (SPT) and Manor and Keset received SPT alternated with Activities of Daily Living with Skills Function (ADLSF) treatment.
- Moshe (pilot case) is not included in the calculation of the total mean in the graph.

For further information see Tables 6 and 7.

Analysis of Graph 3 indicated a large improvement in independent sitting of the participants, as follows:

**Moshe** - (Pilot): Post-intervention test 1: PIA showed that water treatment produced a large improvement in quality of rest during at rest free sitting. All three judges/raters noted this improvement.

**Manor** - Post-intervention test 1: showed that PIA water treatment produced an improvement in quality of sitting and balance during at rest free sitting. Post-intervention test 2: showed that PIA water and land treatments, resulted in the greatest improvement in sitting quality and balance during at rest free sitting, more than was shown in the results of post-intervention tests 1 and 3.

Post-intervention test 3: land treatment was less beneficial to free sitting quality and balance when compared to treatments 1 and 2.

**Avi** - Control (c): Post-intervention test 1: PIA water treatment. Avi received no water treatment. The data showed a negative result, no improvement in quality and balance of at rest free sitting. This was approximately the expected result. Post-intervention test 2: there was no treatment with PIA water, but there were land treatments, which resulted in a greater improvement in the sitting quality and balance than post-intervention test 1, which Avi did not receive. Post-intervention test 3: showed that there was a greater improvement after land treatment and greater benefit to free sitting quality and balance compared to treatments 1 and 2.

**Maor** - Post-intervention test 1: Showed that PIA water treatment produced slight improvement in quality of rest during at rest free sitting, but much less than was shown in post-intervention tests 2 and 3. Post-intervention test 2: PIA water and land treatments, produced the greatest contribution to improved sitting quality and balance. Post-intervention test 3: showed that land treatments benefited and improved free sitting quality and balance, more than was shown at post-intervention test 1 of water treatment.

**Keshet**-Post-intervention test 1: Showed that PIA water treatment produced a large improvement in quality of rest during at rest free sitting. Post-intervention test 2: showed that PIA water and land treatments improved the sitting quality and balance, but much less than treatment assessed at post-intervention test 1. The major difference was in the strategy of PIA water treatments employed. Post-intervention test 3: indicated that land treatments did not improve free sitting quality and balance, showing negative results.

## **IRO Summary**

Analysis of data produced at the different test points for the three intervention treatments-1, 2 and 3 seems to suggest the following conclusions:

According to Graph 3, all participants benefited from the treatments and improved their free sitting quality and balance.

### **Highest results of intervention:**

Post-intervention test 2 indicated that water and land treatment combined exhibited the highest mean improvement of free sitting quality and balance.

### **Lowest results of intervention:**

Post-intervention test 1 and post-intervention test 3: indicated that both water and land treatments applied in isolation produced similar lowest mean results and they were less beneficial for free sitting quality and balance than treatment 2. If one considers the results of improved MP in the pilot case in 16 sessions of water PIA within in 19 days (Table 6, Chapter 3: Methodology) then it is seen that water treatment applied in isolation produced a better improvement than treatment in a land environment alone.


## **Question 1: Summary of Quantitative Results**

The results of the total treatment programme seem to suggest the following: All participants benefited from the treatments and improved free sitting quality and balance. Post-intervention test 1 indicated that PIA water treatment produced better results in proportion to the amount of treatment, when compared to the effect of other treatments. Post-intervention test 2 indicated that PIA combined water and land treatments produced the highest results of intervention and this was the longest intervention providing the greatest contribution to free sitting quality and balance. Post-intervention test 3 showed that land treatment alone produced the lowest results and was less beneficial to free sitting quality and balance than treatments 1 and 2.

### **4.1.2 Improved Free Sitting according to the Qualitative Tool**

The RQ were employed to investigate the participant's sitting before, and after the treatments guiding the researcher to describe how the pupil with CP sat on the stool without support or assistance. Descriptions obtained from the participants, their parents, Teacher, Teacher Assistant, Physiotherapist, Conductor (Maguire and Sutton, 2005, p.35) Conductor's Assistant (CA) and/or caregiver in the pre-intervention interviews were compared with the status reflected in the post-intervention interviews in order to analyse any such

improvement. This comparison focused on the different parts of the body and their position and functioning. These findings are presented separately for each case.

			
Moshe- Pilot	Manor- research ; Avi- control	Maor	Keshet

**Moshe** - findings appear in Appendix 3: RQ 1: Qualitative Findings:

#### **A. Manor - The Research case (r): Findings relating to Improved Sitting**

The analysis of interviews pertaining to Manor indicated that Manor, his parents, the Physiotherapist and his Teacher were all convinced that there was a significant improvement in Manor's sitting position after the treatment.

The improved sitting position that was noted in the interviews before and after the treatments related to a number of issues (categories):

##### Improved upright position and sitting quality:

**BEFORE THE TREATMENT:** Manor's mother, Physiotherapist and Teacher noted that Manor's legs were tied fast when he sat in a chair with a backrest, this was to prevent falling. The parents described his sitting in a wheelchair i.e. with a backrest and all body parts supported included legs. Manor and his mother described the possibility that he might fall from free sitting on a stool. Manor, his parents and the Physiotherapist explained that it was important for him to sit with support or a backrest. Manor and the Teacher described Manor's unstable independent sitting.

**AFTER THE TREATMENT:** a significant improvement was described. There was an improvement in free sitting on a stool (without a backrest). Manor's mother, the Physiotherapist and the Teacher described how he sat on a stool. His mother said: *'His sitting is alright ... Sometimes I can see that he is trying'*. Manor felt an improvement in free sitting and claimed that he sat in class and at home. The Physiotherapist and the Teacher described Manor's control of arms and legs and the fact that he was now holding his head with a straight back.



There is no more fear of falling:

BEFORE THE TREATMENT: Manor and his mother described how they were afraid when he sat unaided on a stool, because Manor admitted that he sometimes fell.

AFTER THE TREATMENT: Manor's mother noted that he managed to sit unaided. Manor himself admitted that before the treatments he was afraid of falling off the stool, and after the treatments he was no longer afraid of falling. For example in an interview with Manor he said: *'I feel better about my sitting'*. The researcher asked him: *'When you sit today, are you afraid of falling?'* Manor answered: *'No!'* The Researcher asked for affirmation: *'You're not afraid of falling, right? And in the summer before The Researcher arrived, were you afraid of falling?'* Manor: *'Yes! Before the treatment - Yes!'*

Improved sitting for a relatively long time:

AFTER THE TREATMENT: the Teacher described Manor's continuous sitting on a stool *'for a few minutes'*.

Improves independent sitting: Manor's sitting quality

BEFORE THE TREATMENT, Manor's sitting was as described above.

AFTER THE TREATMENT: Manor's independent sitting on a stool was described directly or indirectly by all the interviewees, for example, his mother said, *'And then I tell him, if you can, every now and then release your hands and sit alone without the chair in the front. And really sometimes I see that he is trying, and then he says to me: "Mom, look, this is great, I am sitting without putting my hands on the chair in front or on the table"'*. Another example, from the interview with the Teacher: *'It is evident that Manor is able, for a few minutes, to sit continuously with an upright back'*.

Improved motivation:

AFTER THE TREATMENT: Manor described his motivation in an interview as follows: The Researcher: *'Don't you want to sit?'* Manor: *'Yes, I do want to sit'*. The Researcher: *'You want to sit, great! So why don't you ask your mom to help you to sit every day'*. **Manor:** *'Because she doesn't have time'*.

Improved feeling of confidence:

AFTER THE TREATMENT: Manor indirectly describes this feeling. The Researcher: *'When you sit today are you afraid of falling?'* Manor: *'No!'*

A study of these findings indicated that in all the categories, the interviewees noted a significant improvement in Manor's sitting position.

## **B. Avi - The Control Case (c): Findings Pertaining to Improved Sitting**

Avi served as a control case (c), he lives in an institution, therefore the caregiver is like a mother to him. Avi does not speak and therefore he cannot be interviewed.

Analysis of the interviews pertaining to Avi indicated that the caregiver, Physiotherapist, Teaching Assistant and Teacher were all convinced that sitting improved significantly after the treatment. The improved sitting position that was described in the interviews before and after the treatments related to a number of issues (categories):

### Improved upright position and sitting quality

BEFORE THE TREATMENT: the caregiver said that Avi did not sit independently and used a wheelchair- supports were therefore essential for sitting. The Physiotherapist and Teacher described Avi sitting on a bench with his back to the wall and using the wall as a back support. Sitting was not stable and not upright. Avi's body tilted forwards and also fell over in all directions, to the extent that it endangered his safety.

AFTER THE TREATMENT: a significant change in sitting was observed. The caregiver and Teacher described straightening of the head, back and body. The Teaching Assistant described an improvement in head posture, while the caregiver and Physiotherapist noted strengthening and stability of the back. The Teaching Assistant described a positive change, and it could even be said that Avi enjoyed sitting.

### There is no more fear of falling

Avi does not speak and therefore this fear was described indirectly in two examples reported by the environment.

BEFORE THE TREATMENT: There was a threat to safety: the Physiotherapist said: *'He (Avi) falls sideways, forwards and also backwards. This was not safe and we did not manage to progress'*.

AFTER THE TREATMENT: the Teaching Assistant describes an improvement when Avi sat on the stool: *'He sits on a stool, we try to put him against the wall (in case he falls) for safety reasons'*.

### Improved sitting for a relatively long time

BEFORE THE TREATMENT: the Physiotherapist described free sitting that only lasted for a few seconds.

AFTER THE TREATMENT: the Physiotherapist, Teacher Assistant and Teacher described an improvement, sitting time had increased to half an hour and more. For example the Teacher said: *'He can sit like this for over half an hour'*.

### Improved independent sitting

BEFORE THE TREATMENT: the caregiver described Avi as sitting in a wheelchair, and not sitting independently. The Physiotherapist and the Teacher described Avi sitting on a bench, using the wall as a backrest.

AFTER THE TREATMENT: all the interviewees directly or indirectly described Avi's independent sitting on a stool or bench, for example: In the interview with the caregiver, *'After Avi had therapy with the researcher, he eventually sat on a stool without a backrest with his arms crossed. His legs were at a 90 degree angle'.*

### Improved motivation

AFTER THE TREATMENT: the caregiver and the Teacher described an improvement in motivation as a result of the fact that Avi was now able to sit upright. Avi pushed himself and expressed himself so that his presence was felt, because he wanted to see everyone and establish social contact with the people around him.

### Improved feeling of confidence:

AFTER THE TREATMENT: Avi's Teaching Assistant described an indirect improvement in his feeling: *'When I put him on a stool, I think he relates to this positively, that he is quite happy to sit, and I think that this is a refreshing change for him, even at this level. He enjoys this, and he does not..., not only does he not object, he is even pleased'.*

A study of these findings indicated that in all the categories the interviewees felt that there had been a significant improvement in Avi's sitting position.

## **C. Maor - Findings Pertaining to Maor's Improved Sitting**

Analysis and interviews pertaining to Maor indicate that Maor and his parents, the Physiotherapist, Conductor, CA and Teacher are all convinced that there was a significant improvement in Maor's sitting after the treatment.

The improved sitting position that was expressed in the interviews before and after the treatments referred to a number of issues (categories):

### Improved upright posture and sitting quality

BEFORE THE TREATMENT: the parents, Physiotherapist, Conductor, CA and Teacher described unstable sitting, a curved back, that was cypotic (rounded back) hypotonic (low muscle tension), and bending forward. The mother, Physiotherapist, and Conductor described how Maor sat with straight legs. The father, Physiotherapist and Teacher said that

Maor's head faced downwards towards the floor. The father and Conductor described arms held close to the body. All these resulted in an unstable and unbalanced sitting.

AFTER THE TREATMENT: a significant improvement was noted. Maor's parents and CA described his new upright position. Maor himself joined his parents and Physiotherapist in describing an improvement in his sitting position. His mother, Physiotherapist and CA described how his sitting had become more upright. The Physiotherapist and Conductor described an improvement in head posture. The mother, Physiotherapist and Conductor described the fact that his arms were now freed for improved functioning. The Conductor and Teacher described an improvement in bending the legs when sitting.

#### There is no more fear of falling

BEFORE THE TREATMENT: Maor himself, the Physiotherapist and CA described a process of falling during independent sitting.

AFTER THE TREATMENT: Both Maor and the Physiotherapist said that there was no longer any fear of falling and this was a significant improvement.

#### Improved sitting for a relatively long time

BEFORE THE TREATMENT: Maor's mother and Teacher described his ability to sit freely for a number of seconds and sometimes minutes.

AFTER THE TREATMENT: The Conductor and Teacher described a significant improvement when sitting. The Physiotherapist also noted that Maor could not sit independently for more than five minutes before the treatments, yet after the treatments Maor was able to sit for 80 min (Diary, July 7<sup>th</sup> 2005, p.68).

#### Improved independent sitting

BEFORE THE TREATMENT: Maor's father, Conductor and Teacher emphasised that Maor needed protection and supervision in order to be able to sit independently unsupported on the stool. The Physiotherapist said that Maor could not sit on a stool without support.

AFTER THE TREATMENT: the Conductor and Teacher described a significant improvement so that Maor was able to sit independently without support and supervision.

#### Improved motivation:

AFTER THE TREATMENT: this improvement was described by the CA *'Let's say that in his motivation, yes, there is a difference, a big difference'*, in his desire to do ADL skills, like sitting and following instructions of proper behaving.

### Improved feeling of confidence

AFTER THE TREATMENT: Maor's Teacher also related to the dimension of Maor's significantly improved confidence. *'So it is really wonderful to see that he sits on a stool, he feels confident, he does not need supervision, he holds himself, he does not need a lot of verbal instructions'.*

### Improved sitting as a result of the PIA using the TTC

AFTER THE TREATMENT: Maor, his parents, the Physiotherapist, CA and Teacher all describe a significant improvement in sitting as a result of treatment with the PIA using TTC. For example, in an interview with his mother: The Researcher: *'Does the TTC help Maor's sitting?'* Mother: *'Yes, yes'* and in an interview with Maor, The Researcher *'It is very important for you to say that "I do succeed", because when we went into the water it was more difficult for you, right?'* Maor: *'It was more difficult for me on land'.* The Researcher: *'On land, was it easier or more difficult for you?'* Maor: *'More difficult'.* And in an interview with the Teacher—The Researcher: *'Do you think that this gradual exposure in the water-TTC helps him to sit?'* Teacher: *'OK, is it efficient? In my opinion the therapy sessions were efficient, this is obvious'.*

\* It should be noted that after the treatment the CA expressed her great surprise at the strong impact of the change in sitting. *'I was completely astonished'*, she said twice.

A study of these findings indicated that in all the categories the interviewees felt that a significant improvement had been achieved in sitting.

## **D. Keshet - Findings Pertaining to Improved Sitting**

Analysis of the interviews pertaining to Keshet indicated that Keshet, her parents, the Physiotherapist, Conductor and Teacher are all convinced that there was a significant improvement in Keshet's sitting after the treatment. The improved sitting position that was described in the interviews before and after the treatments referred to a number of issues (categories):

### Improved upright posture and sitting quality

BEFORE THE TREATMENT: the parents, Physiotherapist, Conductor and Teacher all described different means of support that they used to help Keshet to sit. Keshet, her parents the Physiotherapist and Conductor described and explained problems of falling during free independent sitting.

Her parents, Keshet, the Physiotherapist and Conductor described her calls for help when free sitting. The mother, Keshet and the Teacher described and explained that it was necessary to straighten parts of Keshet's body in free sitting, and the Conductor emphasised the straight position of her legs, which harmed sitting quality. Keshet herself and the

Conductor described her sitting in a position with her back bent forwards, and the Teacher described tilting of the back and head.

AFTER THE TREATMENT: there was a significant improvement. Expressions of amazement relating to sitting quality: Her mother: *'A great change'*. Father: *'A total surprise... I would never have imagined... I am very happy, really'*. Conductor: *'This is a something that is very new for us... There is a great improvement'*. Teacher: *'It was very impressive'*. The father and Conductor described an improvement in posture and position of the back and body. The Teacher added that Keshet was now able to sit and hold herself stable independently. The mother, Physiotherapist and Conductor described improved holding and motion of the head including the back. The mother and Physiotherapist described a difference in sitting before and after the therapies. The Physiotherapist described less falling, more control of movement, a firm back and ability to use arms for support when getting up and to stabilise sitting. Keshet does not *'lean over to the sides'*.

#### There is no more fear of falling

BEFORE THE TREATMENT: Keshet, the Physiotherapist and Conductor describe anxiety, fear and danger of falling from free sitting on the stool.

AFTER THE TREATMENT: Keshet was less afraid because she was accustomed to the water environment and this was a significant improvement.

#### Improved sitting for a relatively long time

BEFORE THE TREATMENT: Keshet, her parents the Physiotherapist and Conductor all described her ability to sit freely for a number of seconds up to one minute.

AFTER THE TREATMENT: the mother and Conductor described a significant improvement in sitting time, from 50 seconds up to *'almost one hour'*.

#### Improved independent sitting

BEFORE THE TREATMENT: the Physiotherapist and Conductor described a situation where it was not safe to leave Keshet by herself in free sitting. The Teacher also noted that she sat in a wheelchair all day.

AFTER THE TREATMENT: the mother, Keshet, Conductor and Teacher described a significant improvement in independent and free sitting on the stool. The mother and Conductor also noted independent sitting without support.

### Improved motivation

AFTER THE TREATMENT: Keshet described this improvement in an interview as follows: The Researcher: *'So what is important?'* Keshet: *'For me to progress...'*. The Researcher: *'And who does this progress depend on?'* Keshet: *'Me and my family'*.

### Improved feeling of confidence

AFTER THE TREATMENT: Keshet and the Teacher described the significant improvement in confidence. Two examples from the interviews are: with Keshet - The Researcher: *'How did you feel when we were alone in the swimming pool, were you tranquil, like this?'* Keshet: *'More confident'*; and with the Teacher: *'I don't know whether there is also something in her feeling of confidence, she succeeded in sitting by herself, and succeeded in making movements [of the trunk] up and down,[SPT] that are not simple'*.

### Improved sitting as a result of the PIA using the TTC:

AFTER THE TREATMENT: Keshet and the Physiotherapist described the improvement as a result of the described PIA. Examples from the interviews: with Keshet – The Researcher: *'Because this is some kind of device-TTC that will help us. Do you really feel that it helps us?'* Keshet: *'Yes'*. Physiotherapist: *'It is easier to achieve things in water, and the body learns them and can transfer them to land, and this is the real goal, and this is the great benefit of the water'*.

### Question 1 - Summary of Qualitative Results

A study of these findings indicates that in all the categories, all the interviewees experience a feeling of significant improvement in free sitting on the stool.

## **4.2 Research Findings Pertaining to the Improved HHC for ADL Functioning (Research Question 2)**

Tables: 10 (RQ 2) above and 16 below show the different tools used in the triangulations. Triangulation between quantitative and qualitative results.

'Investigator' triangulation was also enabled since the same phenomenon yielded positive findings from quantitative data gathered with two observations tools SACND and RSADLOT.

Triangulation between methods used three quantitative tools (incorporating 'time' triangulation) which was compared with qualitative NDFI both pre and post-intervention. Both types of data were used to evaluate dynamic ability to sit during reaching with HHC while participants' practiced ADL functional abilities. The following table shows which tools were used to gather data to respond to Question 2.

**Table 16:**  
**Data Collection for Research Question 2**

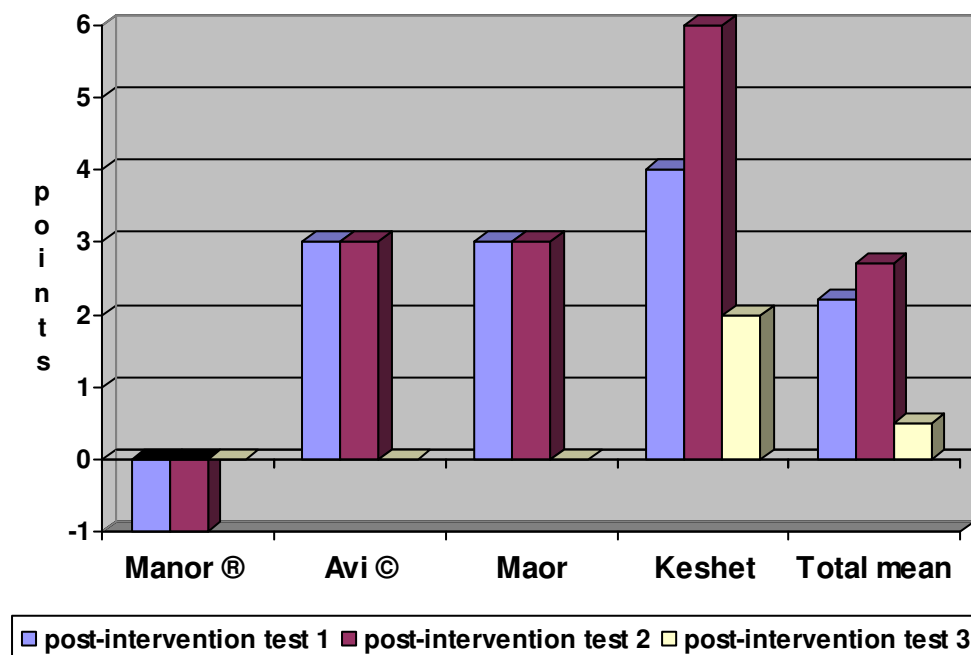
Research Question 2	Quantitative Research Tools	Qualitative Research Tools
1. How and why did the Hand-Head Coordination (HHC) used in functional Activities of Daily Living (ADL) abilities differ for participants with CP during free sitting on land, after intervention?	1. Rating scales observation, is the SACND. The dynamic module evaluates ability to sit during reaching. 2. Rating scale ADL Observation Test (RSADLOT), during free sitting. 3. Rating scales questionnaire using Gross Motor Function Measure (GMFM).	1. NDFI

#### 4.2.1 Quantitative Research Findings pertaining to Improved ADL Function focused on Observation and Video Film

##### A. Observations were rated according to SACND (Reid, 1997)

The reaching module was used to answer RQ 2. Graph 4 below shows differences in results for reaching module for all participants (excluding the pilot participant) between pre-intervention and three post-intervention evaluations).

**Graph 4:**  
**Differences in Sitting Posture measured according to Judged SACND Reaching Module Evaluation (in points) between Pre-Post intervention tests, each Participant representing different amounts of Treatments in different Treatment Environments**  
R - Research c - Control





The reader is reminded that the three tests (post-intervention, 1, 2 and 3) whose results are presented in the above graph related to the following treatments:

- Post-intervention test 1 (blue columns) relates to effect of PIA water treatment with the following lengths of treatment (in minutes): Moshe-720, Manor-1200, Avi-0, Maor-1440 and Keshet-960.
- Post-intervention test 2 (brown columns) relates to effect of PIA water and land treatment with the following amounts of treatment (in minutes): Manor-2020, Avi-820 (land), Maor-2640 and Keshet-2580.
- Post-intervention test 3 (yellow columns) relates to effect of land treatment with the following amounts of treatment (in minutes): Manor-820, Avi-820, Maor-1200 and Keshet-1620.
- Moshe Manor and Avi received Strength Posture of the Trunk (SPT) and Manor and Keshet received SPT alternated with Activities of Daily Living with Skills Function (ADLSF) treatment.
- Moshe (pilot case) is not included in the calculation of the total mean in the above graph.

Analysis of Graph 4 indicated a large improvement during reaching of the following participants( except for Manor).

**Manor-Research (r):** At post-intervention test 1, PIA water treatment, showed a negative result. PIA water treatment did not improve quality of reaching during free sitting. At post-intervention test 2, PIA water and land treatments, showed a negative result. Both strategies did not improve quality of reaching during free sitting. Post-intervention test 3 showed that land treatment, yielded no improved quality of reaching during free sitting. Land treatment did not produce negative results in comparison to post-intervention tests 1 and 2.

**Avi-Control (c):** Post-intervention test 1 related to PIA water treatment. Avi had no water treatment. An improvement of sitting and reaching was clearly noticed. It is suggested that this improvement may stem from another source such as another variable that affects the child outside the researcher's knowledge and influence. At post-intervention test 2 no treatment of PIA water had been provided, but there were land treatments with positive improvements. Post-intervention test 3 related to land treatment. The result of 0 points suggests that the land treatment did not benefit the free reaching if compared to post-intervention tests 1 and 2.

**Maor**-Post-intervention test 1 showed that PIA water treatment produced improvement in reaching during free sitting. Post-intervention test 2 showed that PIA water and land treatments improved the quality of reaching during free sitting, but the result was equal to the result of post-intervention test 1-water treatment. It is also noted that the same results were achieved with nearly double the amount of intervention. Post-intervention test 3 related to land treatment, which was not shown to contribute to reaching during free sitting, when compared to treatments tested at post-intervention test 1 and 2.

**Keshet**-Post-intervention test 1 showed that PIA water treatment produced an improvement in reaching quality during free sitting. Post-intervention test 2 showed that PIA water and land treatments improved the quality of reaching during free sitting, more than PIA treatment tested at post-intervention test treatment 1, however, with more than double intervention time (Table 6). Post-intervention test 3 related to land treatment, which produced a lower contribution to the quality of reaching during free sitting, compared to post-intervention test 1 and 2. The relative effectiveness of the different treatment environments is shown in illustriat in Table 17 below.

**Table 17:**  
**Effectiveness of Intervention in different Environments measured by SACND**  
**Reaching Module:**

**Input - Participants' Treatment Time (in minutes)**

**Output - Amount of Improvement (in points)**

Environment	Manor		Avi		Maor		Keshet		Total mean	
	Min	Points	Min	Points	Min	Points	Min	Points	Min	Points
<b>Water</b>	1200	-1	0	3	1440	3	960	4	900	2.2
<b>Water+ Land</b>	2020	-1	820	3	2640	3	2580	6	2015	2.7
<b>Land</b>	820	0	820	0	1200	0	1620	2	1115	0.5

**Min=minutes**

Total mean of PIA water treatment (900 minutes per 2.2 points) produced better results in proportion to the amount of treatment, compared to post-intervention test 2: PIA water and land (2015 minutes per 2.7 pionts), and post-intervention test 3: land treatment (1115 minutes per 0.5 points).

**Summary:** The post-intervention tests for all three intervention treatments, 1, 2 and 3 indicate the following conclusions:

#### Efficiency of intervention:

The total mean of Post-intervention test 1 shows that PIA water treatment, produces the best results in proportion to the amount of intervention, compared to treatments tested at post-intervention tests 2 and 3.

#### Highest results of intervention:

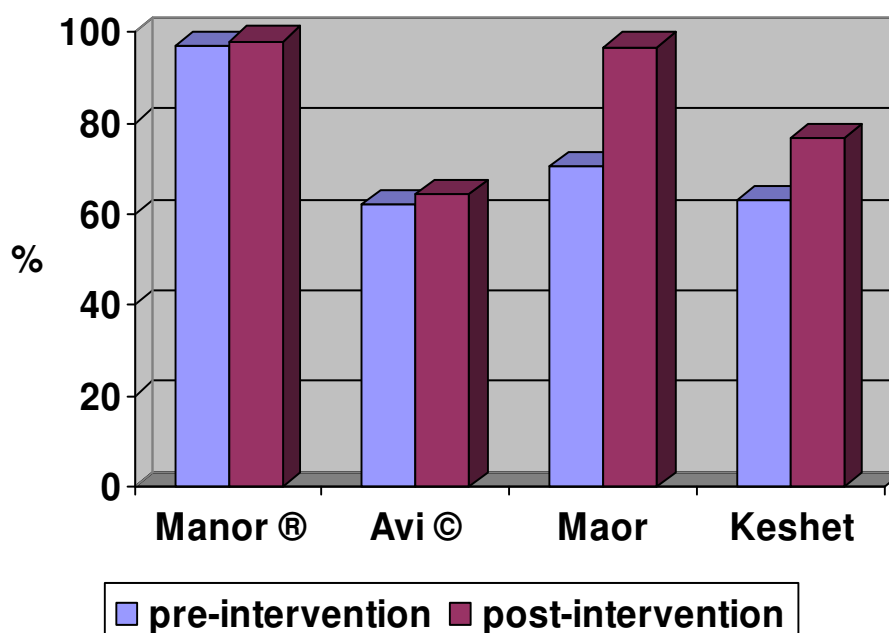
The total mean of post-intervention test 2 indicated that PIA water and land treatments used together were the longest intervention with the greatest contribution to reaching during free sitting, compared to treatments tested at post-intervention tests 1 and 3.

#### Lowest results of intervention:

Post-intervention test 3 showed that land treatment, produced a lower contribution to the quality of reaching during free sitting, compared to results of post-intervention test 1 and 2.

Rating scale ADL observation test (RSADLOT), during free sitting, described by Cohen et al. (2000, p.309). Graph 5 below shows the differences in results for all participants (excluding the pilot participant) as shown in the sitting RSADLOT between pre-intervention and post intervention tests. The calculation of total % in pre- and post-intervention evaluations for each participant was conducted according to the formula presented by Russell et al. (1993 p.37, see Chapter 3: Methodology Analysis of Quantitative Tools-RSADLOT).

**Graph 5:**  
**Differences in evaluation of Participants' Achievements for Sitting RSADLOT (in %)**  
**between Pre-Post intervention tests, by Participant**  
 R - Research c – Control



Analysis of Graph 5 indicated some improvement during free stool sitting, while performing ADL activities with HHC for the following participants:

**Manor-Research (r):** The difference (based on type of treatment) in results between pre-intervention and post-intervention tests suggests a small increase in Manor's ability to touch body points and improved quality of ADL skills functioning using HHC.

**Avi-Control (c):** The difference (based on type of treatment) between results of pre-intervention and post-intervention test suggests that Avi experienced a greater improvement than Manor in touching body points and greater improvement in quality of ADL skills function of HHC.

**Maor-**The difference between pre-intervention and post-intervention test results suggests that 40 PIA water and 4 land treatments established a greater improvement in touching body points and greater improvement in quality of HHC and ADL functioning skills than the improvement achieved by Avi, Manor and Keshet.

**Keshet-**The difference between pre-intervention and post-intervention test results suggests that 16 PI water and 27 land treatments established a good improvement (less than Maor achieved) in touching body points and also an improved quality of ADL functioning skills using HHC.

**Summary:** Evaluation of the pre-intervention and post-intervention test results for the three treatments seems to indicate the following conclusions: First, all participants displayed improved quality of ADL skills function using HHC. Second, the graph shows a clear difference between the results for Manor and Avi, which are low, and the high results achieved by Maor and Keshet. Third, Maor's treatment tested at post-intervention test 2 demonstrated the highest results with the most PIA water treatments -40-and just 4 land treatments, compared to the results of treatments provided for other participants.

**C. Rating scales questionnaire** (Cohen et al., 2000, p.253), using the GMFM (Russell et al., 1993). The participants received pre-treatment, then individual intervention according to the research program, following which post-intervention tests took place for treatment evaluation.

Table 18 below shows the differences in functioning abilities following treatments for all participants (excluding the pilot participant) between pre-intervention and post-intervention tests, according to the Rating Scales Questionnaire-GMFM.

**Table 18:**  
**Differences in achievements of different participants between Pre-and Post-intervention tests for each Dimension (in %) as a result of the different Treatment Environments, according to Rating Scales Questionnaire-GMFM\***  
R - Research C – Control

Activity Pupil Name	Lying-down and Rolling	Sitting	Crawling and Kneeling	Standing	Walking Running & Jumping	Total GMFM
	Numbers relate to percentages of dimension					
Manor ®	0	-1	3	1	1	1.83
Avi ©	3	1	2	-1	9	4.44
Maore	1	-2	-2	3	0	0.32
Keshet	1	4	0	0	0	1.72
Total Mean	1	0.5	0.75	0.75	2.5	2.07
Total Amount	4	2	3	3	10	8.31

\*Calculated according to the formula presented by Russell et al. (1993) See Chapter 3: Methodology, Table 9: p.109.

Analysis of Table 18, shows that some improvements are apparent in the status of the general functioning of the following participants:

**Manor-Research (r):** Improvement in total GMFM: the highest results achieved in crawling and kneeling. His sitting regressed and there was no improvement in lying and rolling.

**Avi-Control (c):** Improved the most in total GMFM with the highest results achieved in walking, running and jumping. He showed an improvement in all the skills but regressed in standing. Avi had highest total GMFM score.

**Maor-**improved in total GMFM with the highest results achieved in standing. He regressed in sitting, crawling with kneeling and did not improve in walking, running and jumping.

**Keshet-**improved in total GMFM with the highest results achieved in sitting. She did not improve in crawling and kneeling, standing, walking, running and jumping.

**Summary:** According to Table 18, the total mean showed that all participants progressed, improving their general status of functioning.

### **Question 2: Summary of Quantitative Results**

The analysis of total results for the different treatments seem to suggest the following:


1. All participants displayed improved quality of HHC during improved performance of ADL functional skills. Post-intervention test 1 showed that the PIA water treatments achieved the most efficient intervention. Post-intervention test 2 showed that the PIA water and land treatments achieved the highest intervention results. Post-intervention test 3 showed that land treatment alone, produced a lower contribution to the improvement of reaching during free sitting.
2. Maor and Keshet showed a greater improvement in HHC for ADL functioning skills in comparison to Manor and Avi.
3. All the participants showed an improvement in their general functioning status.

#### **4.2.2 Improvement of ADL Functioning according to Qualitative Tool Findings**

The RQ were employed to investigate the participant's sitting before, and after the treatments. The question guided the researcher to describe how the pupil with CP sat on the stool without support or assistance. The description focused on the different parts of the body and their position. These findings are presented separately for each case.

The objective of this RQ was also to discover whether there was any improvement in the participants' HHC during their practice of ADL functioning as described by the participants, their parents, Teacher, Teacher Assistance, Pysiotherapist, Conductor, CA and/or caregiver before and after the treatments and to analyse such an improvement.

The question aimed to describe how the pupil sat unassisted on a stool and completed ADL functions using HHC. Examples: cleaning the mouth, bringing a handkerchief to the mouth area, brushing hair, brushing teeth and eating. These findings are presented separately for each case.

			
Moshe- Pilot	Manor- research ; Avi- control	Maor	Keshet

**Moshe-** see Appendix 3: RQ 2: Qualitative Findings.

#### **A. Manor-research Findings pertaining to improved HHC during ADL functioning practice**

Analysis of the interviews pertaining to Manor indicated that Manor, his parents, the Physiotherapist and Teacher were all convinced that there was a significant improvement in Manor's sitting after the treatment.

Manor's pre-intervention status described in the interviews before the treatments and his improved ADL functioning that was described in the interviews after the treatments related to a number of issues (categories):

##### Improved use of hands' functions when sitting

BEFORE THE TREATMENT: both parents and the Teacher described Manor's need for assistance for his functional capacity: Mother: *'Yes, and she works with him, because he cannot do it alone....'* The Researcher: *'She helps him, supports him'*. Mother: *'She helps him'*.

The Physiotherapist and Teacher described problems of hand movement in ADL functions. Two examples: the Physiotherapist: *'But sometimes he puts both hands in a high guard position'*. The Physiotherapist: *'They [his hands] are not stable and he doesn't have control over them...'* The Researcher: *'He doesn't have good control over his [hand] movements'*. Teacher: *'There are no [voluntary hand] movements'*.

AFTER THE TREATMENT: there was a lack of improved function. His parents said that they could not see any difference in function. For example, The Researcher: *'Is there any function between the hands and the mouth area?'*, Mother: *'The same, I didn't notice anything different'*. The Researcher: *'There was no change! OK'*.

### Fear of Falling

BEFORE THE TREATMENT: the Physiotherapist describes a case of falling: *'There are cases, here and there, where perhaps he falls, but it is almost not apparent here'*. On the other hand:

AFTER THE TREATMENT: the Physiotherapist says *'When he does this [uses the hand functionally], most of the time, he can maintain his sitting position. Sometimes he leans forwards, sometimes he leans sideways, but in general, he retains a sitting position'*.

### Improved HHC for ADL skills

BEFORE THE TREATMENT: Manor, his mother and the Physiotherapist described ADL skills as something that Manor found it difficult to perform. Functioning was only possible with the assistance of a chair backrest and support. Two examples: The Researcher: *'Where will it be easier for you to drink your and hold the handle of the cup, when you are sitting on the stool? Without a backrest? Or when you are sitting in a wheelchair with a backrest?'* Manor: *'When I am sitting in a wheelchair with a backrest'*. Physiotherapist: *'He kicks his legs forwards and receives support'*.

AFTER THE TREATMENT: there was an improvement in the ability to function when sitting: Manor, the Physiotherapist and the Teacher all described an improvement.

For example: The Researcher: *'If someone wants to give you a cup of tea, do you want to sit on a stool or in the wheelchair? Where do you want to receive the tea?'* Manor: *'On the stool'*, in other words, without a backrest.

### Improved reaching out

AFTER THE TREATMENT: Manor describes this improvement. The Researcher: *'But if you stretch out your hand and he gives you bubblegum, can you stretch out your hand to take the bubblegum?'* Manor: *'Yes, um... yes!'*

### Improved independent function

AFTER THE TREATMENT: the Physiotherapist described this independent sitting. *'Other things, such as oral hygiene, lifting things to his mouth, he does this completely independently and freely'*.

### Improved motivation

AFTER THE TREATMENT: the mother described improved motivation: *'Look, you [the Researcher] came here every day and made demands from him, so he understood that there were demands and he made an effort. He wanted to do more. He knew that he had to progress with something'*.

A study of these findings indicated that in all the categories the interviewees experienced a feeling of significant improvement in HHC during practice of improved ADL functioning.



## **B. Avi- Findings pertaining to improved HHC during ADL functioning practice.**

Analysis of the interviews pertaining to Avi indicated that the caregiver, Physiotherapist, Teacher and Teaching Assistant are all convinced that there was a significant improvement in ADL function during the therapy.

The pre-intervention status described in interviews before the intervention and the improved ADL function that was described in the interviews after the intervention related to a number of issues (categories):

### Improved quality of hand functions when sitting due to improved sitting

BEFORE THE TREATMENT: the caregiver, Physiotherapist and Teacher all described sitting problems that affected hand function. Examples: Caregiver: *'It used to be very difficult to feed him, because he sat very very hunched over, almost with his head on the table'*. Physiotherapist: *'He does not retain a sitting position'*. Teacher *'He has a tilt'*. The Researcher: *'[Leaning] always towards the hemiplegic side, the weak side'*.

AFTER THE TREATMENT: the caregiver, and Physiotherapist described improved sitting. For example: Caregiver: *'He sits upright, when he brings his hands to his mouth, then he straightens up... Since The Researcher straightened his back, he simply eats better... because he sits upright'*. Physiotherapist: *'There is a slight improvement in that he doesn't fall when moving his hand, as was the case before... He doesn't lose his balance when sitting when he does this'*.

### Improved functioning

BEFORE THE TREATMENT: the Physiotherapist describes problems of hand function. *'We failed to advance, mainly because his hands were not at all functional in providing support'*. The Researcher: *'There was no functional activity. There is no function, no support, we are talking about no support'* (when sitting). Physiotherapist: *'Nothing'*.

AFTER THE TREATMENT: there was an improvement. Physiotherapist: *'I did say that I saw some change in hand function, although slight ... From the aspect of the hands, the right hand is almost non-functional, apart from being a support hand in a very crude manner. The left hand functions better'*.

### Improved form and dexterity of the hands

BEFORE THE TREATMENT: the hands are described as problematic. For example: Physiotherapist: *'He does not do it because his hands are not good... No, the hands are in high guard position, the back is in high guard position, because the right hand is in a pathologic state and he uses his entire body to maintain a sitting position'*.

AFTER THE TREATMENT: the Caregiver, Teaching Assistant and Teacher describe an improvement in hand function. For example: Caregiver: *'He does try to take things, but his movements are quite clumsy, but he does try to take them. He takes things from the table and puts them into his mouth...'*. The Teaching Assistant: *'He can sometimes be observed, perhaps reaching out with his hand, or pulling his friend's chair, even something like that...'* The Teacher: *'He succeeds in moving objects that are near him'*.

#### Improved reaching out

AFTER THE TREATMENT: the Caregiver described Avi's reaching ability: *'He [Avi] takes things from the table and puts them into his mouth... when he [Avi] takes the biscuit, chocolate or bread'*.

#### Improved HHC for ADL skills

AFTER THE TREATMENT: there is a significant improvement in ADL skills, described by the Physiotherapist and Teacher as follows: Physiotherapist: *'He does reach his mouth when sitting, to a certain degree, maybe to eat, to wipe his mouth, to swat a fly. Very basic things'*. Teacher: *'Avi succeeds in putting food in his mouth, as his head is very, very much bent in the direction of the hands, especially with the dominant hand, which is the left hand'*.

#### Improved motivation

AFTER THE TREATMENT: the therapist describes how Avi (on a wheel chair) pushes himself to reach every activity and event. *'And all the time Avi, Avi he wants to be pushed everywhere'*. Avi repeatedly calls out his name for attention because he wants help to be pushed to the centre of the group activities.

A study of these triangulated findings indicated that in all the categories the interviewees felt there had been a significant improvement in HHC and ADL functioning.

### **C. Maor-Findings pertaining to improved HHC during ADL functioning practice.**

Analysis and interviews pertaining to Maor indicated that Maor, his parents, the Physiotherapist, Conductor, Conductor's Assistant (CA) and Teacher are all convinced that there was a significant improvement in Maor's sitting after the therapy.

The pre-intervention status described in interviews before treatment and the improved ADL functioning mentioned in the interviews after the treatments related to a number of issues (categories):

#### Improved quality of hands functioning when sitting

BEFORE THE TREATMENT: Maor, his father, the Physiotherapist, Conductor and CA described his inability to use his hands functionally, an ability described by the Conductor as *'nil to minimal'*.

The Physiotherapist, Conductor, and CA described a lack of balance when sitting and a tendency to fall and the Teacher says that he cannot be left alone when sitting. The CA and Teacher both describe the need to support the body when sitting for hand function, either by Maor himself or by external assistance.

#### Improved HHC for ADL skills

Maor's mother, the Physiotherapist, Conductor and Teacher describe skills that Maor found it difficult to perform or could not perform at all, for example: Conductor: *'When sitting on a chair without support [stool], Maor was unable to feed himself, comb his hair, put on his glasses, put on a hat, scratch his forehead and so forth'.*

AFTER THE THERAPY: there was an improvement in Maor's ability to function when sitting, as described by Maor, his parents, the Physiotherapist, Conductor and Teacher, who all described improved HHC and ADL functional skills. For example: to bring a teaspoon to his mouth, to drink and bring a cup without a handle to his mouth, to eat a sandwich, to remove swimming goggles, hat and glasses, to put on glasses, to put his hands on his head and to get dressed and undressed.

#### Improved reaching out

BEFORE THE TREATMENT: there was no ability to reach out, as described by the Physiotherapist and CA. Two examples: the Physiotherapist: *'He could not use his hands, and it was very difficult for him'.* The Researcher: *'He couldn't reach out with his hand'.* CA *'True,[he couldn't] reach out with his hand'.*

AFTER THE TREATMENT: Maor, the Physiotherapist, Conductor and Teacher described a significant improvement in reaching out with his hands while separating the movements between the right and left hand. For example: The Researcher: *'If you do this, which hand do you use to do it?' Maor: 'With the right hand and the left hand'.* The Researcher: *'Do you do it by reaching out?' Maor: 'By reaching out'.* Physiotherapist: *'I was astonished when I saw him using his left hand and right hand separately'.* Teacher: *'The ability to sit on a stool, to reach out with his hands'.*

#### Improvement in movement of fingers

AFTER THE TREATMENT: the father and Physiotherapist describe separation of movement and better finger function. Two examples: Father: *'Simple function of fingers, really'.* Physiotherapist (with wonder): *'His fingers are freer... I'm amazed, I thought that his hands and fingers [only] worked together'.*

Statements expressing wonder at the improved function: After the therapy, the father says: *'And it was very, very surprising ... He made such a show of intent and determination, which was very, very surprising'*. The Physiotherapist: *'He can do it, I'm in shock... And it was a great surprise for me, and you know what? I was also astonished when I saw him using his left and right hand separately'*. Conductor's Assistant (CA): *'I don't remember that he did things like that'*. Teacher: *'And this is an improvement! .... The ability to sit on a stool, to reach out with his hands'*.

#### There is no more fear of falling

BEFORE THE TREATMENT: the CA described the fear factor that affected function when sitting. For example: *'He sat all the time and his hands were on the stool because of his fear, and his head was usually facing downwards... It was very difficult for him because of his fear, that he was afraid that he would fall'*.

AFTER THE TREATMENT: the CA said, *'I didn't see that he was afraid, and he could do it'*.

#### Improved independent function

AFTER THE TREATMENT: Maor, his mother, the Physiotherapist and the Teacher described his new independence and discovery of an independent personality:

Mother: *'He wants things...[and says] "I want to eat alone", "I want [to do it] alone" [with wonder] He took the swimming goggles off by himself. He actually took them off all by himself'*. The Researcher: *'Do you do this by yourself?'* Maor: *'Yes'*. Physiotherapist: *'He can do a lot of things when sitting like this... It is most important I think, that he can do a lot of things alone, without help, without supervision'*. Teacher: *'All these abilities enable more independence... It is especially Maor, he is a child who likes to do things and he does not like being dependent ... less dependent on his friends and, in other words, more able to connect to his independent personality'*.

#### Improved motivation

AFTER THE TREATMENT: the mother, CA and Teacher described this as follows: Mother: *'He asks more frequently to do things alone... he tries more'*. CA: *'He can, with his willpower, he does it'*. Teacher (relating to Maor's expressions): *'Although the sky is the limit and I can still improve [my functioning], and I can still do more, also from a physical aspect'*.

A study of these triangulated findings indicated that in all the categories the interviewees felt there had been a significant improvement in Maor's HHC and ADL function.

### **D. Keshet-Findings pertaining to improved HHC during ADL functioning practice**

Analysis and interviews pertaining to Keshet indicated that Keshet, her parents, the Physiotherapist, Conductor and Teacher were all convinced that there was a significant improvement in Keshet's ADL functioning after the treatment.

The pre-intervention status described in interviews before treatment and the improved ADL functioning mentioned in the interviews after the treatments related to a number of issues (categories):

#### Improved quality of hand functions when sitting:

BEFORE THE TREATMENT: Physiotherapist: *'In free sitting (on a stool) there is no possibility of achieving hand-mouth function'*. Conductor: *'And then no function can be made with the hands'*. The Conductor and Teacher both described how assistance was given to Keshet during functioning. For example: Conductor: *'The only condition in which [hand to] chest function exists is if there is the assistance by a staff member'*.

AFTER THE TREATMENT: Keshet, the Physiotherapist, Conductor and Teacher all described significant improvement in arm functions. Two examples: The Researcher, *'Can you think about other things that can help you?'* Keshet: *'About independent functioning.'* The Researcher: *'About independent functioning, you say'*. Keshet: *'Yes'*. Conductor: *'And also in her functioning while maintaining the position, in her hand functions'*.

#### Some functional problems.

BEFORE THE TREATMENT: Keshet: *'Because of involuntary movements'*. and also, the Conductor: *'She also increases the muscle tone in her hand and her hands are brought to a flexion position'*.

#### Sitting function for a relatively long time

AFTER THE TREATMENT: the mother and Teacher describe this in the context of Keshet's functioning. For example: Mother: *'She [Keshet] could not hold a carrot or cracker for more than a few seconds before it fell. Now [after the treatment] she holds things for more than an hour'* [HHC skills].

#### Expressions of wonder at the improved functioning

AFTER THE TREATMENT: the mother and Conductor made the following remarks: Mother: *'It is really a great surprise for me, and a lot of work'*. Conductor: *'There is a great improvement... a very very significant improvement'*.

#### Functional sitting

BEFORE THE TREATMENT: the mother and father described Keshet's sitting in an insert in a wheelchair with a belt and support. For example: Mother: *'The insert, with a belt as support... here for the stomach and legs'*.

Before the treatment, Keshet and the Physiotherapist described Keshet's sitting with her hands on her knees as a form of self-support (also mentioned by Moshe) and any reaching increased the leverage and increased the instability of her sitting. For example: The Researcher: *'When you sit on a stool, where are your hands?'* Keshet: *'On my knees'*. The Researcher: *'Very good, on your knees'*. The Physiotherapist and Conductor explained how stabilised sitting required effort. For example: Conductor: *'Maintaining stability requires so much energy from her'*.

AFTER THE TREATMENT: the Physiotherapist, Conductor and Teacher all described a significant improvement in stability during functional sitting. Two examples: The Researcher: *'This Bobaths principle where first we need to strengthen the back.... We won't search for functioning without having stability in the hips and back, in order to hold the upper part of the body'*. Physiotherapist: *'The rotation that we saw, this is really stability within the movement or movement within the stability. I definitely agree with what you said'*. Teacher: *'To experience her body in a positive, strong and stable way'*.

#### Improved reaching out

AFTER THE TREATMENT: the Conductor and Teacher described improved reaching out. Conductor: *'Keshet is also able to aim at a specific object and also to increase her range of motion'*. Teacher: *'To make herself pretty, put on makeup and hold up the mirror in front of her'*. Improved movement and dexterity of fingers

AFTER THE TREATMENT: the mother, father and Conductor described an improvement in the grip of the fingers. For example: Father: *'Truth is, when we give her something to hold in her hand and eat, she does it better than in the past'*.

#### Improved HHC for ADL skills

BEFORE THE TREATMENT: the parents, Physiotherapist and Teacher all described skills that Keshet was only able to perform when sitting in a wheelchair with support, and not when sitting freely. Two examples: Mother: *'Sometimes she can even remove her hair band, and she is in the wheelchair'*. Teacher: *'She can try to hold certain foods and bring them towards her mouth'*.

AFTER THE TREATMENT: the improved functioning assisted better organisation in the wheelchair, and in fact the wheelchair restricted movement. Teacher: *'Perhaps this will improve her ability to manage in a motorised wheelchair... But the movement [functional hands] is definitely more restricted when she is sitting in the wheelchair'*.

BEFORE THE TREATMENT: the parents, Physiotherapist and Teacher all described skills that Keshet did not succeed in performing. Two examples: Father: *'So she takes the edge of the towel*

*and tries to clean her mouth'. The Researcher: 'I understand. Can you take a toothbrush and put it into your mouth?' Keshet: 'No!'*

AFTER THE TREATMENT: the parents, Physiotherapist, Conductor and Teacher described a significant improvement. Three examples of the skills are described below. The Researcher: *'You are starting to function with your left hand, to bring the toothbrush to your mouth, to remove it from your mouth'*. Conductor: *'She is able to bring her toothbrush to her mouth, to keep her hand in her mouth, to make movements in her mouth'*. Teacher: *'... to wipe her mouth with a towel, to put a toothbrush in her mouth without help'*.

#### Improved independent function

AFTER THE TREATMENT: Keshet's independence is described in the context of her skills by Keshet, the Conductor and the Teacher. Examples: The Researcher: *'Your independent functioning, in other words, that you need to do things alone and you don't need help from anyone else, does this make you happy?'* Keshet: *'Yes...'* The Researcher: *'You say that it gives you self confidence. How does it give you self confidence?'* Keshet: *'I am able to do things alone without help'*. Conductor: *'If she [Keshet] succeeds in maintaining this functioning that was observed in the video film' [after the treatment]*. Teacher: *'To eat independently with a fork, but she put the food in her mouth by herself'*.

#### The water area reduces fear of falling

BEFORE THE TREATMENT: Keshet described her fear of falling when sitting. The Researcher: *'And if heaven forbid you start to fall, then what happens to you hands?'* Keshet: *'They are up'*.

AFTER THE TREATMENT: Keshet said that the water area reduced her fear – giving her a feeling of security. The Researcher: *'Was there less fear when you were sitting in water for the first time than you had on land?'* Keshet: *'Definitely'*. The Researcher: *'In other words, you were more comfortable in the water. You say that it was easier for you to sit in the water than to sit on land. Am I right?'* Keshet: *'Definitely'*.

#### Improved motivation

AFTER THE TREATMENT: this change is described by Keshet. The Researcher: *'But after this you want to continue to advance in this direction of sitting and functioning with hands on your head'*. Keshet: *'Definitely'*.

These findings indicated that in all the categories the interviewees felt there had been a significant improvement in Keshet's function which had been achieved by the improvement of her sitting abilities and improved HHC and ADL skills.

## Question 2 - Summary of Qualitative Results

A study of these triangulated findings indicated that in all the categories all the interviewees felt that a significant improvement had been achieved in HHC during practice of improved ADL functioning during free sitting on the stool. Avi's positive results are discussed in paragraph 5.2.2: Problematic Issues relating to the Cases of Manor and Avi, see header: Avi Control Participant.

### 4.3 Research Findings Pertaining to Improvement in the Participants' Perceived Competence (Research Question 3)

Tables 10 above (RQ 3) and 19 below show the different tools employed in three types of triangulation. Data from NDFI underwent time triangulation comparing data from pre and post intervention baselines. Enhanced triangulation was possible since the same phenomenon yielded positive quantitative-numerical data collected from rating scales of the questionnaire, and descriptive findings from interviews, thus achieving triangulation between methods and data triangulations. The data gathered from these MMD evaluated the participants' PC before and after intervention.

**Table 19:**

**Type of Tool and Data Collected to answer Research Question 3**

Research Question 3	Quantitative Research Tools	Qualitative Research Tools
How and why did the PC of participants with CP vary as a result of the intervention?	1. Rating scales questionnaire, using the Pictorial Scale of PC in Israeli Children with CP (PSPCICCP).	1. NDFI

#### 4.3.1 Quantitative Research Findings Pertaining to the Improvement of PC of Children with CP

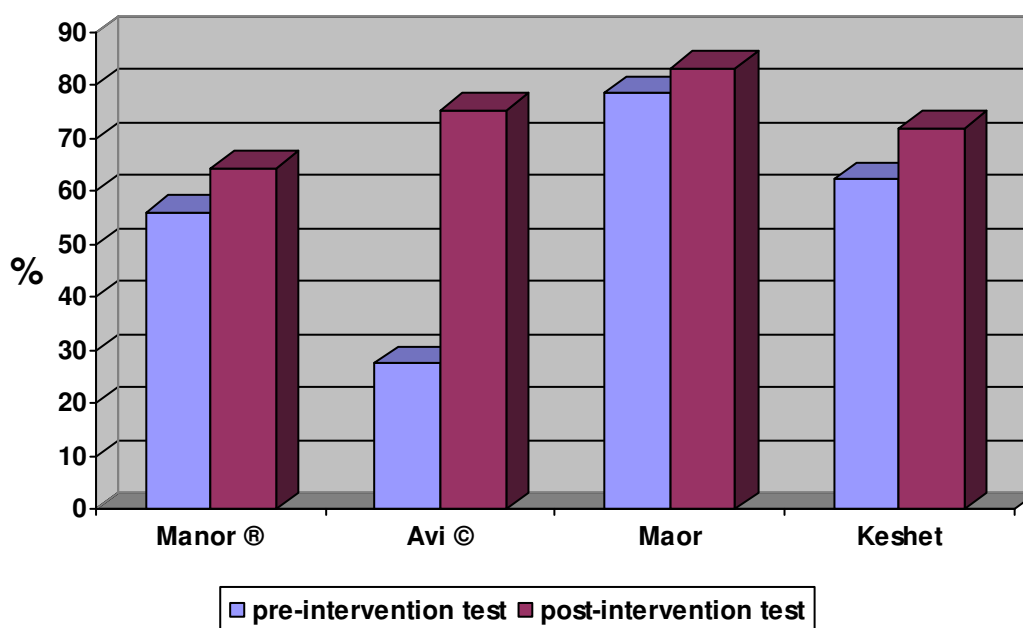
Quantitative data were derived from the rating scales questionnaire using the PSPCICCP (Schneider, 1996, see Table 5: No. 9). Graph 6 below shows differences in the competence of all participant's competence (excluding the pilot participant), between pre-intervention and post-intervention evaluations.



**Graph 6:**

**Differences in Findings for Perceived Competence (total raw measures in percentages) between Pre-intervention and Post-intervention tests, by Participant**

R - Research c - Control



Analysis of Graph 6 indicated obvious improvements in the PC of the participants as noted below. The graph shows that all participants dramatically improved their level of PC after the intervention treatment.

The highest PC was achieved by: First Avi, second Keshet, third Manor and fourth Maor. The total mean percentage of increase after the treatments is 17.65% for all participants (see Appendix 19: Table 1).

### **Question 3: Summary of Quantitative Results**


The difference in PC between pre-intervention and post-intervention test results indicated an improved PC for all the research participants following the intervention.

#### **4.3.2 Improved PC of the Children with CP according to the Qualitative Tool**

The RQ aimed to produce descriptions of the alteration (if any) in the participant's PC, from their status as reflected by the participants, their parents, Teacher, Teacher Assistance, Pysiotherapist, Conductor, CA and/or caregiver in the pre-intervention interviews to the status reflected in the post-intervention interviews and to analyse such an improvement.

Answering the question required a description of the participant's self-image: their perception of themselves, their perception of the way others saw them and the participant's social status within his/her environment. The interviewees were asked to indicate: What was the participant's status in their peer group, in class, with friends, in extracurricular activities,

in other activities? This could include reference to: leadership, charisma, shyness, anger, outbursts of laughter, introversion, communication with adults, and family. These findings are presented separately according to each case.

			
Moshe-Pilot	Manor – research ; Avi - control	Maor	Keshet

**Moshe-** see Appendix 3: RQ 3: Qualitative Findings

#### A. **Manor-** Findings relating to improved PC

Analysis and interviews pertaining to Manor indicate that Manor, his parents, the Physiotherapist and the Teacher are all convinced that there was a significant improvement in Manor's competence at the end of the therapy.

The improved competence that was expressed in the interviews before and after the treatments related to a number of issues (categories):

##### Physical motor success improved the child's emotional state

BEFORE THE TREATMENT: Manor, his mother, the Physiotherapist and the Teacher all describe a poor emotional stage, sadness, depression, and uncontrollable, helpless laughter. Examples: Mother: *'He has a strong tendency to moods, very strong. He can suddenly become very closed and introverted ... He has ups and downs'*.

In an interview with Manor-Researcher: *'When something in your life bothers you?'* Manor: *'Something in my life...'* Researcher: *'Would you like to be like everyone else?'* Manor: *'Yes.'* Physiotherapist: *'He also laughs a lot... Sometimes it's in the wrong place'*. Teacher: (in relation to laughing) *'There is helplessness and sometimes shouting... He loses control.'*

AFTER THE TREATMENT: The parents describe a significant emotional improvement. Two examples: The mother: *'The changes are in the swimming pool in the afternoon. First of all he is organised every afternoon this year, starting from September, and this really reassured him... This year he knows exactly what he is doing in the afternoon, so he has simply changed'*. Father: *'He has an activity in the afternoon'*.

##### Improved behaviour

AFTER THE TREATMENT: the Teacher described the improvement: *'I must say that I see a lot of joy as soon as you come to treat him. There is great pleasure from his activity'*. Joyful pleasurable activity was associated with improved positive behaviour as opposed to bad moods and *'shouting... [or] losing control.'*

### Social improvement

BEFORE THE TREATMENT: Manor and his mother described very little social activity, with few friends. Examples: Mother: *'There aren't a lot of boys downstairs now, only girls, so he isn't interested, and he doesn't even want to go down'*. Interviewing Manor – Researcher: *'Do you have friends in the neighbourhood?'* Manor: *'No, no!'* Researcher: *'Don't you have any friends that you can play with in the neighbourhood?'* Manor: *'I used to have'*. Researcher: *'You used to have, but now you don't have'*. Manor: *'Yes'*. Researcher: *'How many friends do you have there?'* Manor: *'Five'*.

AFTER THE TREATMENT: Manor, his father, the Physiotherapist and Teacher describe an improvement in his social life and more friends. Examples: Father: *'He has many more friends than last year'*. Researcher interviewing Manor: *'Do you feel any change from a social or other aspect?'* Manor: *'Yes'*. Researcher: *'How many friends do you have?'* Manor: *'Seven'*. Physiotherapist: *'He always has a lot of friends'*. Teacher: *'In his relationship with his friends, he is friendly and pleasant, he likes others, he is happy to be with others, he cares about them'*.

### Improvement in the school environment

BEFORE THE TREATMENT: the Physiotherapist and Teacher described a limited physical motor capability. For example: Physiotherapist: *'Because of Manor's physical disability, he cannot participate in this activity, so he sits on the side'*. Teacher: *'The physical function is very low. He is the only one who doesn't walk, so from that aspect he feels restricted... in physical games he feels inferior to his friends...'* Researcher: *'And you said that his legs are tied'*. Teacher: *'His legs are tied with belts when he sits'*.

AFTER THE TREATMENT: Manor, his father and the Teacher describe an improvement at school. For example: Researcher: *'Now you sit at school without belts that tie your legs to the chair?'* Manor: *'Yes!, I feel that I sit well at school ...'* Researcher: *'How you feel now at school, do you feel better than before you met the Researcher?'* Manor: *'It was less good, before I met the Researcher'*. Researcher: *'In other words, the Researcher came and gave you all kinds of treatments when you were sitting in and out of the water, and this made you feel better at school?'* Manor: *'Yes...'* Researcher: *'The treatments in the swimming pool helped you?'* Manor: *'Yes'*. Researcher: *'How did they help you?'* Manor: *'They made me feel good... I feel good in class'*. Teacher: *'I think that Manor is becoming more aware of the influence of the physical aspect on his learning ability'*.

### Improved motivation

BEFORE THE TREATMENT: the Teacher described lack of motivation. Example: *'At the beginning of the year we saw that Manor had difficulty, it can be described as laziness in his desire to do anything, in his desire to cope with the motor aspect and with the physical aspect'*.

AFTER THE TREATMENT: the parents, Physiotherapist, and Teacher described an improvement in motivation. Examples: Mother: *'But he knew that he was required to do something; that you [the researcher] did not come everyday for nothing, and he thought about this'*. Father: *'He was motivated to think how we could help him to advance in swimming'*. Physiotherapist: *'So when he is told to sit up straight, and he is reminded of all the work he did recently in the pool, this gives him some energy, and as a result, I think that he tries harder to sit straight and he regards it as a challenge. Because we expect it from him, and he wants to meet the challenge'*. Teacher: [describing Manor's expressions] *'I want to stand more... I want to stand for an hour'*.

#### Improved confidence and self-esteem

BEFORE THE TREATMENT: the father and Teacher describe Manor's lack of confidence and low self esteem. Examples: Father: *'When Manor sits, he lacks self confidence'*. Teacher: *'In school [with other] children, where he has difficulty, then he has very little self confidence'*. AFTER THE TREATMENT: the Teacher described improved confidence and self esteem. Examples: *'I can say that Manor does indeed know how to stand up for his rights. He knows how to answer his friends... He is also able to ask for the help that he needs, to say things candidly to people, even when they are not so pleasant'*.

#### Improved determination

AFTER THE TREATMENT: the Physiotherapist and Teacher describe an improvement in determination. Examples: Researcher: *'My intervention bound him to some degree of commitment, that he wants to succeed, and you can see the difference, in his willingness to improve, that he does what that he is told in a better way, is this what you are saying?'* Physiotherapist: *'Yes!'*

Teacher: *'He says, I want to stand more... I want to go for physiotherapy'*.

A study of these findings indicates that in all the categories the interviewees feel a significant improvement in competence.

#### B. Avi- Findings relating to improved PC

Analysis of the interviews pertaining to Avi indicated that the caregiver, Physiotherapist, Teacher's Assistant and Teacher were all convinced that there was a significant improvement in Avi's competence after the treatment. The improved competence that was expressed in the interviews before and after the treatments related to a number of issues (categories):

#### Physical motor success improved emotional state

BEFORE THE TREATMENT: the Physiotherapist and Teacher describe egocentricity. The Teacher described a poor emotional state, sadness, tendency to cry and high sensitivity.

Examples: The Physiotherapist: *'He is very very stubborn and he wants things to be as he knows them and as he wants'.* Teacher: *'Look at him, he is very involved with himself, in other words, it is important to him what is happening to him. He is very sensitive. If he hears someone saying that he has to go home today, or to some kind of treatment, he immediately starts crying. He is sensitive to those around him and to his environment.. If there is something sad, he starts to cry. If it is something that is unpleasant, then he is very sensitive'.*

AFTER THE TREATMENT: the caregiver, Physiotherapist and Teacher described a significant emotional improvement. Example: The caregiver: *'He laughs, he is a happy child, he is a laughing child. He does not get insulted... And he involves us... Because this child is simply a nice boy, a happy and attractive child... And then his mood also improves'.* Physiotherapist: *'He is always a happy child... very happy'.* Teacher: *'It was the researcher's intervention that affected him, I think... and I am sure that it did have an effect, that someone from outside comes, relates to him, devotes some time to him, then of course the feeling is different'.*

### Improved behaviour

BEFORE THE TREATMENT: the caregiver and Teacher describe outbursts of shouting, impatience, wild behaviour and pranks. Examples: Caregiver: *'When something is brought to class, he constantly shouts: "Avi, Avi, Avi". He simply needs to fight to get something.... He needs to be the first... He simply needs to fight for bread, for everything... I think that at home, he needed to shout and fight and he continued with this, at the institution... He is impatient... He doesn't have time to wait'.* Teacher: *'Avi and another [child], they are together as soon as the other one starts to go wild, they get up to mischief... Each one encourages the other and then there is a real party... Avi starts shouting and makes a big issue of things'.*

AFTER THE TREATMENT: the Teacher described improved behaviour: *'Avi is usually a very easy child. He is in a good mood, he smiles a lot... He agrees to almost everything'.*

### Social improvement

BEFORE THE TREATMENT: the Physiotherapist and Teacher described a poor social situation, without social communication and friends. Examples: Physiotherapist: *'Avi does not initiate communication... compared to others in the class who do... He does not initiate communication with the children in his class...'* Teacher: *'He is not interested in other friends'.*

AFTER THE TREATMENT: the Physiotherapist, Teaching Assistant and Teacher describe a significant social improvement. Examples: Physiotherapist: *'He communicates with the environment, communicates with his friends and with the adults who treat him... I would say that he does not have a level of difficulty from the aspect of communication with the environment. He was always a very open child'.* Teaching Assistant: *'In relation to communication, when he asks for things, and he knows*

*how to clearly define what he wants, and what he needs, I think that I can see this'. Teacher: 'He likes communicating with friends, with therapists that he knows, and also with new therapists who come to the class... He smiles at them and tries to get to know them... He has quite a good social status... Everyone likes him, friends as well as therapists'.*

#### Improved motivation

BEFORE THE TREATMENT: the Physiotherapist described a situation where motivation harmed physical ability. *'From the aspect of motivation, this actually has a negative affect, because his tone increases and he gets so excited and involved in the actual competition, that he can't do anything, and this is detrimental to him'.*

AFTER THE TREATMENT: according to the caregiver, Physiotherapist, and the Teacher, behaviour is modified and this produced improved motivation, i.e. both improved. Sometimes as a reward for positive behaviour, sweets were given. Two examples were described, the Teacher: *'Especially [sometimes - once a week] when he receives positive reinforcement from the Researcher [a sweet], and we spoke about this in class, it is good for him'.* The caregiver described improved motivation without conditioning and reinforcement. *'He [Avi] says yes, "Avi, Avi, Avi", because he simply wants [to be all time the first with most attention] ... If they are playing in the group, then he is prepared to play first... and he always pushes himself [forwards to be first]'.*

#### Improved determination

AFTER THE TREATMENT: the caregiver and Teacher's Assistant describe the improvement Caregiver *'He always pushes himself [forwards to be first]'.* Teacher's Assistant: *'Lately, again I think that it is related to the fact that he stands up for himself'.*

#### Improved confidence and self-esteem

BEFORE THE TREATMENT: the caregiver described a desire for attention, probably stemming from lack of confidence and low self esteem. *'So that Avi will draw attention, so that he will get his share'.*

AFTER THE TREATMENT: the caregiver and Teacher's Assistant describe a significant improvement in confidence and self esteem. For example: Caregiver: *'Avi has real self confidence... And so he always shouts "Avi, Avi, Avi", because he is simply confident'.* Teaching Assistant: *'Relating to what you said, that he wanted things, I think that he stands up for himself more... He is more demanding of what he wants... This could also relate to the matter of self esteem'.*

### Improved physical skills

AFTER THE TREATMENT: the caregiver described physical hand-mouth competence when sitting: *'He is sitting upright! When he puts his hands to his mouth – then he does straightened up... In other words, the movement is more bent and then he straightens up and puts food in his mouth'.*

### Improvement in the school environment

AFTER THE TREATMENT: the Teacher described positive enforcement for Avi's social position in school: *'He [Avi] especially mentioned that getting positive feedback from the Researcher and talking about it in the classroom made him feel good about himself and his social status in his peer group'.*

A study of these findings indicated that in all the categories, the interviewees felt that a significant improvement in competence had occurred.

### C. Maor- Findings relating to improved PC

Analysis and interviews regarding Maor indicated that Maor, his parents, the Physiotherapist, Conductor, CA and Teacher were all convinced that there was a significant improvement in Maor's competence after the treatment.

Maor's initial status was described in interviews before the treatments and his improved competence was expressed in the interviews after the treatments related to a number of issues (categories):

### Physical motor success improved the child's emotional state

BEFORE THE TREATMENT: the Conductor, Conductor's Assistant (CA) and Teacher described outbursts of uncontrolled laughter, irrational thoughts, detachment, egocentricity, outbursts of rage, obsessive thoughts and inflexibility. Examples: Father: *'He said that he hates his legs. He wants to saw them off. He wants to take someone else's legs'.* Conductor: *'He often detaches himself from the group, with obsessive behaviour around subjects that interest him, such as his finger'.* CA: *'The egocentricity, he talks about what he wants, even if it is not relevant'.* Teacher: *'He is stuck in obsessive thought, in personal thought, that is related to him personally, and is not related to the subject... He has outbursts of laughter... and outbursts of rage'.*

AFTER THE TREATMENT: the father, Physiotherapist, Conductor, CA and Teacher all describe a significant improvement in his emotional state, his personal awareness, and his feeling after the treatments. He is quieter, more relaxed and mature. Examples: Father: *'Something in his awareness, his competence, this is what arose much more strongly, recently'.* Physiotherapist: *'There is a great improvement in his personality'.* Conductor: *'There is a lot less involvement with himself and less obsessive behaviour, such as the finger that I noted'.* CA: *'First I would like to say that he is much quieter, much more relaxed'.* Teacher: *'I think that now that he has reached*

*achievements, I think that it also affects him emotionally, and this is very encouraging'.*

### Improved behaviour

BEFORE THE TREATMENT: Maor, his parents, Physiotherapist the CA and Teacher describe abnormal outbursts, not restraining himself, shouting, crying, cursing, and aggression. Examples: Mother: *'He has outbursts when he doesn't get what he wants immediately'*. Mother: *'That is clear!'* Maor: *'Yes'*. Mother: *'No'*. Maor: *'Yes'* [shouts]. Father: *'He has difficulty in restraining himself in all kinds of situations'*. Physiotherapist: *'But there are things that he cannot do and he cries, he shouts... and he curses'*. CA: *'In the beginning he repeatedly said "You're stupid, stupid"'*. Teacher: *'Behavioural disorders...'* Researcher: *'He may attack and scratch'*, Teacher: *'That is true. This is something that I didn't see in other children in my class.'*

AFTER THE TREATMENT: the parents, Maor, the Physiotherapist, Conductor, CA and Teacher all describe an improvement in behaviour, willingness and cooperation. Examples: Mother: *'There is some kind of change in his behaviour towards people'*. Father: *'[It's now possible to] Force him, make him do things and set borders for him'*. Researcher to Maor: *'What has improved?'* Maor: *'My behaviour... has improved.'* Physiotherapist: *'There is a great improvement in his behaviour'*. Conductor: *'There is much more willingness and acceptance of the framework'*. Teacher: *'The fact that he follows instructions is also an achievement'*.

### Social improvement

BEFORE THE TREATMENT: Maor and his mother, Physiotherapist, Conductor and Teacher all describe a poor social situation, abnormal relations, loneliness. Examples: Mother: *'I saw the difficulty. Yes, he is part, but he is not a part.'* The researcher to Maor: *'Do you have friends in the class, at Tamar school'*. Maor: *'No'*. Physiotherapist: *'He also shouts at his friends... He walks around by himself... I didn't see any real connection with the children'*. Conductor: *'There was minimal connection with the peer group'*. Teacher: *'This type of child usually has low social skills... His social skills are poor in the classroom, and during the break he is alone'*.

AFTER THE TREATMENT: the mother, Physiotherapist, Conductor and Teacher all described significant social improvement in more direct and clear communication, Maor taking an interest in himself, in his peers, in relations, and in society. For example: Mother: *'His communication is becoming increasingly direct... and clearer'*. Physiotherapist: *'Maor's communication is stronger'*. Conductor: *'Maor is also more interested in what is happening around him and in his peers and he also does this in acceptable ways, and not in the previously unacceptable ways'*. CA: *'He is able to be more open to connection with others'*. Teacher: *'Maor's social skills have improved very much'*.



### Improved motivation

AFTER THE TREATMENT: the mother, Physiotherapist and Teacher all described significant improvement in motivation. Examples: Mother: *'He says "I will help you, I will do it". Even when it is something that he cannot do, but I feel that it could lead to a greater effort'*. Physiotherapist: *'Now, when he feels that he can succeed [free sitting and function] he is more active. He continues, he doesn't waste time, he doesn't give up'*. Teacher: *'He likes to achieve things and aspires onwards'*.

### Improved confidence and self esteem

BEFORE THE TREATMENT: the father, CA and Teacher all describe situations and behaviour of low confidence and self-esteem, physical pain, insufficient love and attention. Examples relating to physical pain, insufficient love and attention: Father: *'Spastic children can experience such pain inside their body'*. CA: *'Maor simply wants love and attention'*. Teacher: *'Sometimes he tends to speak for other children, but it is as if he is speaking through them, for himself'*. He says, *'"Don't put him in the support, he doesn't want it", and he is actually referring to himself'*.

AFTER THE TREATMENT: the parents, Physiotherapist and CA describe a significant improvement in confidence and self-esteem, in understanding his disability and in his progress. Examples: Mother: *'Two days ago he said, and it was quite surprising, that he doesn't want to be disabled all his life and that I should know that it is very difficult to be disabled'*. Father: *'I felt how he, in some way, subconsciously, experienced something, as if he was saying.... "Look, I managed to confront it and I progressed"'*. Physiotherapist: *'Now [after the intervention], to conquer the movement is the most important thing for him. And it is really good to see him like this... He feels more confident'*. CA: *'I think that the treatment really helped him, perhaps it's his confidence, he is confident, I saw his confidence'*.

### Improved physical skills

AFTER THE TREATMENT: Maor described a number of physical improvements when sitting. Two examples Researcher: *'Which hand did you manage to use [for spraying with a water gun]?' Maor: 'Left and right...'* Researcher: *'What did you spray? Coca Cola?' Maor: 'No, water!'* Researcher: *'Did you succeed in bringing the napkin to your mouth to clean it?' Maor: 'Yes'*. Researcher: *'How many times have you cleaned your mouth?' Maor: 'For the first time'*.

### Improved determination

AFTER THE TREATMENT: this is described by Maor's mother: *'He [Maor] wants things! He tries harder... [he says] I want!'*

### Improvement in the school environment

AFTER THE TREATMENT: the Teacher described a positive 'picture' of integration in school: *'In my opinion, since he has been integrated into "Palm" School it could improve his play skills with friends in the short run and his social skills in the long run'.*

A study of these findings indicated that in all the categories the interviewees felt that there had been a significant improvement in Maor's competence.

#### D. Keshet- Findings relating to improved PC

Analysis and interviews pertaining to Keshet indicate that Keshet, her parents, the Physiotherapist, Conductor and Teacher are all convinced that there was a significant improvement in Keshet's competence after the treatment.

Keshet's initial status as described in interviews before the intervention and her improved competence as expressed in the interviews after the treatments related to a number of issues (categories):

### Physical motor success improved the child's emotional state

BEFORE THE TREATMENT: the father, Conductor and Teacher all described an unstable emotional state based on lack of understanding of her condition, fluctuating moods, passiveness and emotional problems. Examples: Father: *'Despite Keshet's severe problems, I think that there is ... that she is still not completely aware of her condition. Or perhaps it's her nature, her personality'.* Conductor: *'We see that when Keshet is bored and in a bad mood, then her ability to sit freely is poor... And when Keshet is in a bad mood, then she is much more passive, quieter, and this can be seen just by looking at her'.* Teacher: *'I think that it is not because of a mistaken perception of reality, but rather more stems from an emotional aspect'.*

AFTER THE TREATMENT: the Teacher described Keshet's strong and healthy sides due to the influence of the treatment. Examples: *'While she [Keshet] has other aspects, which we discussed before, the cognitive aspect and the verbal aspect are so strong... I am sure that this intensive work can advance her... And at the same time, from an emotional aspect, and from the aspect of cognitive competence, they are connected to and built on each other'.*

### Improved behaviour

BEFORE THE TREATMENT: the parents described behaviour that could indicate the beginning of adolescence. Mother: *'She does not want to be told what to see[TV] and what to eat, when to wash or when to go to sleep and when to brush her teeth... It goes from crying up to a few moments of unpleasantness... But it doesn't bother Keshet whether or not it suits us. She says to us "She [her friend Galit] is staying and you can do whatever you want"'.* Father: *'I can say that there are the cases where she*

*gets annoyed, and it happens often lately, in particular with her friend [Galit]'.*

AFTER THE TREATMENT: the Teacher described more controlled and mature behaviour. For example: *'Because again, Keshet is a child, a young girl who is interested in her environment, is inquisitive and asks questions, and nothing is taken for granted. She wants to know why, what and how'.*

### Social improvement

BEFORE THE TREATMENT: Keshet, her mother, the Physiotherapist and Teacher all described a state of sparse social relations, where Keshet invited only one friend to her home. There was a social gap, lack of communication during the breaks, and loneliness. Examples: Mother: *'The truth is, outside of the school, she has only one friend'*. Teacher: *'I know that she has a friend at home, in the afternoon'*. Keshet: *'I have only older friends'*. Physiotherapist: *'In the breaks I don't see her communicating with the other children in her class... I see her going around alone and not with other children'*. Teacher: *'There is less social communication with the children from the class, because of the emotional gap between them'*.

AFTER THE TREATMENT: Keshet, her father, Conductor and Teacher all describe a significant social improvement, and more assertive communication, she stands up for what she wants, shares the success of the children in her class, there is mature social communication. Examples: Father: *'It is possible that she is more assertive... She stands up for what she wants'*. Researcher to Keshet: *'In other words, the children in the class are your friends and you share this success with them'*. Keshet: *'Yes'*. Conductor: *'She [Keshet] shows interest in all kinds of processes experienced by children of her age: maturation with adolescence, friendships, loves, disappointments and so on'*. Teacher: *'A young girl with the ability to create consistent and significant ties, usually with girls who are older than her, and this is compatible with her personal maturity. And she continues to preserve these relations'*.

### Improved determination and motivation

BEFORE THE TREATMENT: the Conductor described Keshet's decline in motivation as an example of a common phenomenon that occurs with children with CP as they grow older, saying: *'The financial factor is something that I think despite all the difficulty is easier to organise than the children's motivation, since unfortunately, we see that, with an increase in age, the motivation [of the child with CP] to act and work hard in paramedical treatments and, in particular, in physiotherapy, declines'*.

AFTER THE TREATMENT: Hypotheses regarding decreased motivation with increased age disappeared and Keshet, the Physiotherapist, Conductor and Teacher, all described a significant improvement in Keshet's determination and motivation, she was described as pleasant to guide, and they agreed that if there is a desire to succeed, then there is no end to success, determination, insistence and motivation. Keshet wants responsibility and tasks.

Examples: Researcher to Keshet: *'I wrote a birthday greeting for your birthday, saying that the sky is the limit. In other words, you can succeed as much as you want... The more you want, the more you will succeed. What do you think about this?'* Keshet: *'I agree with everything you said'*. Physiotherapist: *'She was aware, and said "I can"'*. Conductor: *'Keshet, the truth is that from the beginning we noticed this ability to cope with difficult tasks in the long term. She has a sort of positive stubbornness. She is able to withstand frustrations and be persistent in her opinion, when she decides to do something, and to do it to the end... This could be one of the reasons for her high motivation'*. Teacher: *'But Keshet's motivation to do things by herself increased, this is something that she has... For example she says that she wants to do all kinds of tasks in the class'*.

### Improved confidence and self-esteem

BEFORE THE TREATMENT: Keshet, the Physiotherapist and Teacher described situations and behaviour that reflected lack of confidence and low self esteem, with a desire for pride and unrealistic competence. For example: The Researcher to Keshet: *'I think that it is most important for you to be proud of yourself'*. Keshet: *'Right, but they will also be proud of me, they will also be proud of me'*. Physiotherapist: *'There is a kind of distorted reality or wishful thinking that she can do it, but in fact she cannot do anything.. I think that her self esteem is generally positive, but unrealistic... This is not a child who is capable of perceiving her real self esteem, she slips between the fingers'*. Teacher: *'Yes, there is something in the way she perceives herself that is less realistic, and this is expressed in reading, which is something that she has great difficulty with, and in her perception that she does read.'*

AFTER THE TREATMENT: Keshet, her father and the Teacher describe a significant improvement in confidence and self esteem, based on: physical achievements, satisfaction, and the desire to show others her progress. Examples: Father: *'I think that in general, the fact that she reached these agreements, by nature, should improve her faith in herself, the faith in her ability...'*

Researcher to Keshet: *'You can stand facing the mirror and bring a brush to your hair, what do you think of that?'* Keshet: *'That would bring me great satisfaction...'* Researcher: *'All these things, what did they do for you?'* Keshet: *'Satisfaction, self confidence and satisfaction'*. Teacher: *'It could certainly be that there is more faith in herself but also to show others what she can do and not only with you... But on the other hand, also because she feels the results [positive achievements, when sitting], then there was also this faith in herself, in her self esteem, in her ability and desire to show others as well'*.

### Improved physical ability

BEFORE THE TREATMENT: the parents described anxiety regarding Keshet's ability to withstand the research treatments. Examples: Mother: *'I am afraid that she [Keshet] will be tired out with a one-hour activity. It could be too much for her'*. Father: *'From this aspect, she has the motivation, but as my wife said, it could be that the time that you allocate to her each time is just a bit too long'*.

AFTER THE TREATMENT: the parents, Conductor and Teacher described a significant improvement in Keshet's physical ability, apparently due to the number of treatments and Keshet's achievements. Examples: Mother: *'I see that the physical side is stronger than the character... intensity of one full hour, four times a week, even though it was in the water in the beginning. I think that she received it well'*. Father: *'I tip my hat to Keshet, who, in her condition, persevered with the long and intensive treatments, four times a week, and this added, in my opinion, to her esteem and competence... What do you think? [to the Researcher]. When you started these treatments, did you expect that Keshet would withstand all these tests with such courage? What do you think of her achievements?*

*I want to hear your assessment'*. Conductor: *'There are four treatments a week, which requires emotional strength'*. Teacher: *'I am sure that this intensive work [the research treatments] could also improve her physically'*.

### Improvement in the school environment

AFTER THE TREATMENT: the teacher described Keshet's motivation in school: *'For example, she said that she wanted to take on more roles and activities that she can do by herself in the class'*.

### Improved motivation of the parents

AFTER THE TREATMENT: the parents describe their desire to continue the momentum created by the treatment. Examples: Mother: *'We are not taking advantage of the reinforcement that she gained, so that she sits alone, for example... perhaps we need to reinforce it [the sitting] more instead of her sitting passively in any chair'*. Father: *'But I think that we need to try to take advantage of this momentum that was created from her treatments, in order to continue, perhaps to really try and improve her daily function, so that she will be more independent'*.

A study of these findings indicated that in all the categories the interviewees felt that there had been a significant improvement in Keshet's competence.

### **Question 3-Summary of Qualitative Results**

A study of these findings indicates that in all the categories the interviewees felt that there had been a significant improvement in competence.

#### 4.4 Research Findings Pertaining to Improved QOL (Research Question 4)

Tables 10 above (RQ 4) and 20 below, detail the type of tools used in the different triangulations. Data triangulation was conducted between quantitative numerical data from different measuring tools and qualitative descriptive data from interviews. Triangulation between methods was possible since the same phenomenon yielded positive findings from the use of six different quantitative tools. Investigator triangulation was also possible since the same phenomenon yielded positive findings from three different observation tools (Tables 10 above and 20 below: SACND RSADLOT and IRO). The quantitative data gathered with these tools was compared with descriptive data from NDFI, relating to QOL, using time triangulation to compare qualitative data gathered from interviews (Table 10: Base Lines before and after intervention: A1 to A3, and to A4 at a one year post intervention test). All these tools were employed to test 'How' or 'Why' participants' QOL (subjective data-child and objective data-parents, staff and quantitative tools), improved?

**Table 20:**  
**Type of Tool used and Data collected to answer Research Question 4**

Research Question 4	Quantitative-Core Research Tools	Qualitative-Supplemental Research Tool - NDFI
How and why was the QOL of participants with CP altered as a result of the intervention, and at follow-up one year after intervention?	Goniometer SACND RSADLOT IRO GMFM PSPCICCP	Data analysis process regarding QOL
		<ol style="list-style-type: none"> <li>1. Developed categories resulting from analysis of data collected before and after PIA intervention.</li> <li>2. Developed categories resulting from analysis of data collected one year after termination of PIA treatments. Comparison and integration of both types of data.</li> </ol>

##### 4.4.1 Assessment of Improvement in QOL according to Quantitative Data tools

In this section data relating to the research questions are presented in the following order: quantitative-core data and then qualitative-supplemental data (see Table 20 above).

The improvement in objective QOL was demonstrated by the change in values of quantitative data collected before and after the intervention. Details of the tools used to collect these data appear in Table 21 below.

**Table 21:**  
**Quantitative Findings: Total mean differences for all participants by measuring tool**  
**between pre-post evaluation of motor improvement**  
**that formed the basis for the evaluation of improvement in physical functioning and**  
**perceived competence domains of QOL**

<b>Research Question 1</b> Testing Improvement in free rest sitting of posture and balance	<b>Research Question 2</b> Testing Improvement in free reach sitting during functional ADL abilities	<b>Research Question 3</b> Testing Improvement in participants' perceived competence
Tools	Tools	Tool
Total Mean of Goniometric improvements is 7.45 degrees	Total Mean of SACND Reach Module improvements is 1.8 points	Total Mean of PSPCICCP improvements is 17.6%
Total Mean of SACND Rest Module improvements is 2.6 points	Total Mean of RSADLOT improvements is 10.8%	
Total Mean of IRO improvements is 23.4%	Total Mean of GMFM improvements is 2%	

The total values for all quantitative data demonstrate a clear improvement during free at rest sitting of posture, balance, reaching, and ADL function thus, enhancing participants' PC.

#### **4.4.2 Assessment of Improvement in QOL according to Qualitative Data from Interviews before and after Intervention**

The aim of the RQ was to investigate participants' subjective and objective QOL before and after the treatments as described by the participants, their parents, Teacher, Teacher Assistance, Pysiotherapist, Conductor, CA and/or caregiver and to analyse and interpret such an improvement. The findings for this question are presented separately for each case.

→			
<b>Moshe- Pilot</b>	Manor- research ; Avi- control	Maor	Keshet

**Moshe** – see Appendix 3: Qualitative Findings, RQ: 1,2 and 3.

Findings relating to improved QOL

A. Manor - AFTER THE TREATMENT: the Teacher describes an improvement in the context of the amount of crumbs scattered after eating and in the way the food is brought to Manor's mouth. *'But I can definitely say that I see much, much less mess on his table. This is first of all. I can now see him eating an apple, eating his sandwich'.*

AFTER THE TREATMENT: this improvement was described by Manor himself, who related to his ability to function from a sitting position. The Researcher: *'Do you move your hands better on the stool than in the wheelchair?'* Manor: *'Yes!'*

AFTER THE TREATMENT: the Teacher described this improvement. Example: *'I see some more development in the fact that he is aware that his motor ability has a very very great influence on his learning ability and on every step in his life. I can say that I did indeed see quite a significant change ... I feel that something definitely changed.'*

**B. Avi** - AFTER THE TREATMENT: the caregiver and Teacher described the improvement in terms of an upright position, which allowed Avi to see people, the group. There was also an improvement in eating and physical strength, social integration and adaptation. For example, the caregiver says, *'He always shouts "Avi, Avi, Avi" because he is upright, he can see us. Since the Researcher straightened his back, he simply eats better.'*

AFTER THE TREATMENT: a significant improvement in QOL is described by the caregiver: *'and ever since The Researcher straightened his back, he simply eats better. The food doesn't fall from his mouth, because he sits upright, so he also eats better, and so, to put it short, the child is happier... and more pleased with himself, and then this is a kind of cycle where if the child is happy, pleased with himself, then he is ready for developments. He eats well, and in the group he also sings with us and plays with us'.*

AFTER THE TREATMENT: the caregiver described this improvement as a result of stability and an upright head and back when sitting. Examples: *'He sees us... He sees all of us.... Also when other volunteers arrive, he follows with his eyes, because he is simply sitting upright and then he has control of the group. The volunteers catch his eye and they approach him quite frequently... So it seems that the treatment did improve his back, his sitting, and then his mood improves, and so he is approached more, and then they play with him, and take him, and want to be with him'.*

**C. Maor** - AFTER THE TREATMENT: there was a significant improvement in QOL. According to his mother *'When his body is upright then he definitely [she laughs], he sees the world differently and this really changes his encounter with the world .... He absorbs things more quickly and then this affects his quality of life'.*

AFTER THE TREATMENT: Maor's mother, Conductor and Teacher described a significant improvement in QOL. Two examples: Mother: *'And then it is wonderful, because he also does it [functions] better'.* Conductor: *'To perform all kinds of ADL that were not possible before the treatment'.*

The interview with Maor after the treatment describes improved functional ability. *'I manage to remove my glasses'.*

AFTER THE TREATMENT: the mother, Physiotherapist and Teacher all described significant improvement in QOL because of improved uprightness, wider vision, inquisitiveness, better eye contact and greater potential. Examples: Mother: *'It is the same (like in upright sitting), when he is in the walker, suddenly he discovers something that he didn't see before'.* Physiotherapist: *'He is*



*more inquisitive when sitting... It is more interesting for him now... It will have a very significant affect on his quality of life.... Of course his quality of life will go up and up!"* Teacher: *"This quality of life is in fact not being dependent, in other words, to be as independent as possible and to utilise the potential. He learned to exploit his potential and increase his competence".*

**D. Keshet** - AFTER THE TREATMENT: there was a significant improvement in the participant's QOL described by the father: *'She establishes more eye contact with the person opposite her, with the person talking to her'.*

AFTER THE TREATMENT: the improved QOL is described by the Conductor: *'I would like to add something regarding the physical aspects and the QOL. These treatments [sitting and function], they are not reduced, only the strength of the muscles, and maintaining balance. We must remember that the whole issue of breathing, for example, the issue of problems of perception, the issue of sight, all the activity of the body's internal organs, what happens to this child when he is bent over all his life. There is accumulated disruption of all the processes, all kinds of accumulated negative effects, which could show signs later, which we are unaware of today. This should also be addressed today'* [upright sitting].

AFTER THE TREATMENT: the Physiotherapist, Conductor and Teacher all described a significant improvement in QOL, based on the change as a result of the treatment, Keshet's straightening up, eye contact, social response and increase in social status. Examples: Physiotherapist: *'Even though I saw the change in treatment, it reinforced me, really, how to work... to really fight for this, what we are really working for, and what quality of life is for these children'.* Conductor: *'And the issue of maintaining eye contact, to see who she is talking to, to show what is happening, this is very very important... when she is upright. The attention, the interaction and the reaction that she receives from society, will be completely different'.* Teacher: *'If we could think about the continuation of this work over the years [PIA work when sitting with functioning and acquisition of skills with a goal], I could see Keshet in a completely different place, more active by herself, looking different, feeling different'.*

#### **4.4.3 The Research Categories that emerged from the Qualitative Findings matched with QOL and HRQOL Domains**

Each qualitative category of findings, that emerged from interviews with the participants, parents and staff was correlated with the related QOL and/or HRQOL domains and compared with the characteristics of each QOL domain indicated in a variety of theoretical and empirical research literary sources - Appendix 22: QOL.

This process is in line with the concepts of Waters et al. (2005) who developed QOL themes which emerged from his research and attributed them to the domains identified by the WHO (1993). The process is also identical to the process conducted by Young et al. (2007), which matched qualitative categories with KIDSCREEN (2006) dimensions. In effect, this comparison, illustrated in Table 22 below, constitutes a form of data triangulation comparing different types of data (quantitative and qualitative data), collected at different baselines (before and after intervention and qualitative data collected 12 months post-intervention). The triangulation considered the total data relating to the concept of QOL gathered by MMD while applying multiple replication of the case studies and thus served to strengthen the validity and reliability of the present research findings and claims.

In contrast, to the two above-mentioned studies, which attempted to match categories to QOL domains, the present study, relied on a larger variety and amount of literary sources and QOL and HRQOL tools, which suggest that study participants with limited capabilities find it difficult to produce adequate subjective reports (see: Matza, Swensen, Flood, Secnik and Leidy, 2004, 2004; Varni et al., 2006; Verschuren et al., 2007; see Chapter 3-Methodology: 3.9.2: Inclusion and Selection Criteria, paragraphs: 6,7,8 and 10-where details are given concerning the participants' functioning and mental abilities and or restrictions) and consequently supplemented the children's subjective reports with objective reports.

Since, the research participants' had limited abilities to present their subjective and authentic views on their QOL, the data were collected using an NDFI combining subjective and objective reports in interviews, and their responses were reinforced by comparing them with proxy objective reports (Varni et al., 2005; 2006; White-Koning, et al., 2007), conducted with the child's parents and school staff and also with the quantitative objective data.

The large amount of literary sources and tools screens seem to suggest: first, that it was necessary to use a wider perspective of the QOL domains to evaluate the improvement for participants with CP. Second, the reader needs an ability to grasp and understand the main and central domains involved in evaluation of QOL for people with CP. Third, a recognition that in the literature on tools used to measure the QOL of people with CP, currently objectives tools are used far more than subjective tools.

Table 22 below matches categories of data (collected before and after intervention) with theoretical QOL and HRQOL domains. The qualitative categories that express the participants' success following treatment were chosen because they emerged frequently from the data with regard to most participants, and were identified by several interviewees, and verified by quantitative methods as positive improvements.

**Table 22:**  
**Categories emerging from the Qualitative Findings matched with QOL Domains\***

<b>Categories of Qualitative Findings verified by Quantitative data</b>	<b>Corresponding QOL Domains</b>
<b>Categories relating to Question 1</b>	
Improves upright posture and sitting quality	Physical Functioning or Mobility
There is no more fear of falling	Emotional Wellbeing, Self-Esteem
Improved sitting for a relatively long time	Movement and Balance Activities
Improved independent sitting	Movement and Balance Activities, Physical Functioning
Improved motivation	Self-Esteem, Emotional Wellbeing, General Happiness
Improved feeling of confidence	Self-Esteem, Emotional Wellbeing, General Happiness
Improved sitting - result of the PIA with the TTC	Movement and Balance Activities
<b>Categories relating to Question 2</b>	
Improved quality of hand function when sitting	Physical Functioning, Global function
Improved HHC with ADL skills	Activities of Daily Living, Self / Personal Care
Improved reaching out	Physical Functioning or Mobility, Global Function
Improvement in fingers	Physical Functioning or Mobility
No more fear of falling	Emotional Wellbeing, Self-Esteem, Behaviour Abilities
Improved independent function	Dependence or Independence, ADL
Improved independent function Improved motivation	Dependence or Independence, ADL Self-Esteem, Emotional Wellbeing, General Happiness
<b>Categories relating to Question 3</b>	
Physical motor success improves emotional state	Emotional Wellbeing, Self-Esteem
Improved behaviour	Behaviour Abilities, Self-Esteem, Emotional Wellbeing
Social improvement	Relations with Other People, Interaction / Speech / Communication
Improved determination and motivation	Emotional Wellbeing, Self-Esteem
Improved confidence and self-esteem	Self-Esteem, Emotional Wellbeing
Improved physical ability	Physical Health, General Health, Physical Functioning
Improvement in school environment	School Activities-Scholastic, Social Wellbeing
Improved parents motivation	Family Activities, Family Cohesion, Family Health
<b>Categories relating to Question 4</b>	
Improved upright sitting, enhanced physical functioning activity with ADL skills e.g. eating.	Physical Functioning or Mobility, Global function Activities of Daily Living, Self / Personal Care
Improved sitting posture enhanced self in psychosocial domains	Behaviour Abilities, Self-Esteem, Emotional Wellbeing, Relations with Other People, Interaction / Speech / Communication
Improved sitting posture enhanced world discovery-adaptation	Relations with Other People, Interaction / Speech / Communication, Emotional Wellbeing, Self-Esteem

\* For domains identification according to literary sources see Appendix 22:

#### **4.4.4 Qualitative Descriptions of Improved QOL of Participants and Families One Year after Termination of Treatment matched with QOL and HRQOL Domains**

The evaluation conducted one year after the intervention through interviews of parents and participants suggests that the adaptation process has continued since termination of treatment with new behaviour improvements taking place in the functioning of the child and the child's family, enabling improved adaptation to the new environmental context and situation (Palisano et al., 2004; Rosenbaum, 2004; Tieman et al., 2004; Verschuren et al., 2007). These improvements are noted below according to a number of categories.

##### Erectness and sitting quality including performance of functions: Preservation of sitting skills

The parents of all participants described improvements of sitting skills including MP used for functioning a year after termination of treatments e.g. Moshe's mother related to his improvement of skills: *'His sitting during the period improved very, very, very much'*. Maor's mother described postural improvements of her child's back one year after the treatment ended: *'He sits very straight...his back is straight'*. The findings relating to this category may be compatible with the following QOL domains (that emerged from a review of various QOL tools-tests, which developed 6 core QOL domains. These 18 tools-tests are not appended due to the vast amount of information involved - for a list of the main tools see Appendix 22: Abbreviations and Description 1): Physical functioning and/or mobility (identified by NHP, SF-36, OPCS, RAP, EuroQol, CHQ, PODCI, TACQOL, WeeFIM, NDP, PedsQL4.0, KIDSCREEN, and for movement and balance activities-PedsQL3.0.)

Keshet's mother-emphasised the development of ADL functional activities: *'Yes, there is an improvement...she can even eat some things by herself, we do not even put it (the handkerchief), in her hand, I put it on the table, she grasps it, and somehow she manages to eat alone, she can eat alone'*. This part of the research findings' category concerning QOL may be compatible with the following QOL domains: 'Eating activities' (identified by scale-PedsQL3.0 and to ADL: NHP, SF-36, OPCS, RAP, EuroQol, PODCI, NDP, QLT, PedsQL3.0).

All the QOL categories examined here may be compatible with these QOL domains: 'autonomy' (identified by TACQOL, KIDSCREEN) and 'physical health' (identified by Flanagan, 1978, CHQ, QOLIP, QLT and general health: CHQ, QLT and CPCHILD).

##### Improved psychological characteristics related to personality, GSW (mentioned also as self-esteem) and PC

The parents of the participants described improvements of GSW and PC a year past after the termination of treatments e.g. Moshe's mother described the effects of his improved

sitting on his self-esteem: *'The sitting gives him a wonderful feeling...of self-confidence...It raises his spirits'*. This category concerning QOL is compatible with the QOL domain of 'self-esteem' (identified by CHQ, TACQOL, QLT, CCHQ) and 'spiritual/religious status' (identified by Spilker, 1996 and QOLIP).

Manor's mother also related to her child's improved emotional state: *'He walks with joy ... He is more relaxed, less tense, happier'*. This part of the research findings' category concerning QOL is compatible with the core psychological domain of QOL known as 'general happiness' (identified by Ferrans (1990, 1992, 1996); PODCI, QOLIP, QLT and CPCHILD).

Keshet's mother highlighted the QOL domain of 'autonomy' (independence versus dependence) which relates to social and motivational aspects of the self. *'You can see the difference, that there is a desire to be more independent... independent in thought... more assertive in thought ... She is not dependant on others. She is not dependent'*. This category concerning QOL is compatible with the QOL category of 'autonomy' (independence versus dependence) identified by NHP, RAP, NDP, QLT. In addition her mother noted that *'there was development in her motivation and desire to do things independently'*. This category concerning QOL is compatible with the core psychological domain of QOL known as 'achievement of personal goals' (identified by Ferrans (1990, 1992, 1996), and the domain of 'emotional wellbeing' (identified by NHP, SF-36, OPCS, RAP, EuroQol, CHQ, QOLIP, TACQOL, NDP, QLT, PedsQL4.0 and KIDSCREEN).

#### Improved social skills

Maor's mother contributed by suggesting a way to improve social skills during negotiations by restraining the emotional outburst *'There is a certain maturity, and in negotiations he has learnt to wait, and not to explode ... He has learnt to be patient in many situations'*. This part of the research findings' category concerning QOL is compatible with the core social domain of QOL known as 'relations with other people' (identified by Flanagan (1978); OPCS, RAP, QOLIP, NDP, KIDSCREEN), and with 'interaction/speech/communication' (identified by CQ, QLT, PedsQL3.0, CPCHILD, CCHQ) and with the core psychological domain cited as 'growth becoming'-learning new things-adjusting to change (identified by QOLIP).

Finally, Keshet's mother provided a report on an improvement in Keshet's social skills in the relations between Keshet and her sibling *'She has changed, also from a social aspect... Yes there is an improvement in her relationship with her siblings, that is true'*. This category concerning

QOL is compatible with the QOL domain of 'social wellbeing' (identified by QLT and PedsQL4.0).

Parents desire and recommendations to renew and continue with the therapeutic intervention ended year ago

The opinion of all research participants' parents (one year after treatment) and the opinion of the parents of the pilot test participant, Moshe, (two years and 8 months after the treatments), was that they had been satisfied with the treatment and would like to continue to receive these treatments e.g. Moshe himself acknowledged the benefits of the treatment: *'I understood that this therapy, this is what helped'*. Manor's father drew a connection between the Researcher's appearance and the research intervention and Manor's developed swimming skill *'Of course there is a connection (to the research). 'Because, if you were not here, then he (Manor) would not have gone to the swimming pool and we also said that we want you to be his trainer'*. Maor's mother suggested that it was a good time to start a second treatment *'This was good for Maor ... So you are invited to do the second stage in the research after the summer'*.

Finally, Keshet's mother pointed out the positive results of the treatment: *'If Niv could continue with the therapy in the context of the school and privately, I think that there would be many parents who would continue with this therapy, because we saw results, it was not simply something up in the air'*. This part of the research findings' category concerning QOL is compatible with the QOL domains of expectations and satisfaction: Ferrans (1990, 1992, 1996); PODCI, QLT, KIDSCREEN and perceptions of the future: RAP, NDP and QLT.

During the research and in one year follow up evaluation is descriptions were obtained that may suggest that parents/caregivers began to take the initiative and changed their behavioural strategy and their attitudes regarding the importance of therapy, expressing greater sensitivity and devoting more of their time to the child with CP.

This change was described by the parents of all participants e.g. Moshe's mother described his parents' motivation to provide additional treatment at home. They used the Researcher's Pilot Study photographs to identify the most appropriate chair as well as posture for their child: *'This means that we sat him on chairs like we saw in pictures and we used this [understanding] at home as well'*. Manor's father explained how the family had changed their behaviour on Saturdays and the family's new procedures for improving Manor's sitting posture. *'So I think that it also made us aware of the importance of making frequent remarks. And now we decided to go out on Saturdays, to take him out, and we do this on a permanent basis, and as soon as he bends over, we stop until he straightens up, and this goes on the whole way. I really attribute this to you-Niv [the researcher]'*.

Finally, Keshet's mother described and gave an example of how the participants' parents had started to demand more from their child as well as correcting their child's posture: *'We saw that she was able [to sit alone] therefore we could ask her to do more things [that can be done] with upright sitting, so in movement or in another situation of the therapy she can be asked to sit more correctly, and then she also helped [us]'*. This part of the research findings' category concerning QOL is compatible with the QOL domain of caregiver/parent impact, and the emotional and time domains: CHQ, KIDSCREEN and positioning / transferring: PODCI, CQ, CPCHILD and CCHQ.

#### Influence of the intervention on closer and healthier family activities and interaction

The parents of all participants (except Avi), described improvements of family activities and interaction which had become closer and healthier, e.g. Moshe's mother described the effect of successful sitting on the happiness of the family *'Whenever there is a physical improvement, of course this makes me very happy, him [Moshe] as well... there was really a period of improvement from this aspect'* and there was also a family connotation of achievement: *'We were all happy and Rachel (the Physiotherapist) and you [Niv], and it were really wonderful'*.

Manor's mother highlighted the improvement of relationship between both of them and Manor's maturation: *'Now too, I tell him that I am going, but he accepts it in a completely different way, much more mature... but here too, he has changed very much'*. Manor's father indicated that the family gathered together for joint activities *'We decided to go out on Saturday... to take him [Manor] out, and we went out regularly'*.

Maor's mother provided an example of family activities where the family gathered together for the pool activities: *'For example, at the swimming pool [at Kibbutz Gazit], when children came in, or his siblings came into the swimming pool again'*.

Keshet's mother indicated how Keshet had improved particularly in her relationship with the family relationship affected family cohesion: *'She [Keshet] can has confidence in her desires when they contradict others, in particular in the family, to do things or not to do them. There is an improvement and we see this'*. This category is compatible with the core caregiver/parents, family domains of QOL known as 'family activities phenomena', and 'cohesion behavior' (identified by CHQ, QOLIP, QLT, KIDSCREEN), and the domain of 'family health activity' e.g. hiking-walking (identified by QLT).

#### **4.4.5 The Integration of Quantitative and Qualitative Research Findings, according to the Four Research Questions (RQ)**

**RQ 1:** The quantitative findings demonstrated that: during sitting all participants improved quality of their at rest free sitting and balance. The most efficient intervention is PIA water treatment. The highest results of intervention were achieved by PIA water and land treatment, while the lowest results of intervention were for land treatment.

The qualitative findings testified to: improved upright sitting position, independent sitting with no fear and with a relatively long time of sitting.

**RQ 2:** The quantitative findings demonstrated that: the research participants improved the quality of their ADL functioning skills during hand-head coordination. The most efficient intervention was PIA water treatment. The highest results for intervention are PIA water and land treatment, while the lowest results of intervention were for land treatment. Maor and Keshet showed better improvement compared to Manor and Avi in hand-head coordination for ADL functioning skills during free sitting. Participants improved their total functioning abilities.

The qualitative findings testified that: during sitting all participants improved their independent physical ADL functional skill ability using hand and head coordination, while focusing on reaching out with no fear of falling during free sitting.

**RQ 3:** The quantitative findings demonstrated that: The participants dramatically improved their level of PC after the intervention treatment. The mean percentage of difference between pre-intervention and post-intervention test results totalled 17.65% for all participants.

The qualitative findings testified that: the participants' physical motor success improved their motivation and emotional state in the social and behavioural fields of as evidenced in their improved self-image, self-esteem, self determination and in improved socialisation in the school environment.

**RQ 4:** The quantitative findings demonstrated that: improvement in: hip flexion ROM, rest free sitting, and reaching modules, ADL skills functioning using HHC during free stool sitting. All these achievements enhanced the participants' PC.

The qualitative findings testified that: participants' improved upright sitting enhanced their performance of functional activity including ADL skills (e.g. eating-HHC), and strengthens self-psychosocial domains, enabling a greater capability for world discovery, i.e. adaptation.



Findings one year after termination of treatment were: sitting skills were preserved including erectness and sitting quality with performance abilities; these achievements enhanced psychological characteristics relating to personality - Global Self-Worth (GSW) (mentioned also as self-esteem), PC and social skills. Avi was not living at home limiting some data collection. The families recommended and desired the continuation of the therapy which had ended one year before, while they reported that they had changed their behaviour and attitude to therapy and devoted more time to their child with CP. The families provided descriptions which indicated closer and healthier family activities and interaction. The study used four types of triangulation (Table 10) with two types of data collected according to two different approaches, including 'between methods' triangulation, investigator triangulation and time triangulation, to establish and reinforce the clear findings that both types of data indicated an overall improvement in QOL domains for the children with CP and their families.

#### **Question 4: Summary of Results regarding Improvement of QOL**

Analysis of the data relating to QOL provided a summary of the achievements for the entire research period, from April 12<sup>th</sup> 2002 until January 21<sup>st</sup> 2007. These data included findings relating to the influence - both intentional and unintentional - of the interventions, including findings from the supplementary qualitative component scheduled during the data-gathering for the main-core quantitative component. Thus after the study was completed, a year after the termination of the therapies, additional NDFI's were conducted. For this reason, the present research can also be regarded as a longitudinal study, providing an extended perspective on QOL over time. The 'neat fit' of the categories that emerged from the findings, with the characteristics of specific QOL domains, allows the researcher to submit the conclusion that the QOL improved as a result of the research intervention for all the families of the children with CP and for the pupils themselves according to the six established domains (see Appendix 22: Description 1).

### **4.5 Chapter Summary**

This chapter described in detail the quantitative and qualitative findings for all participants and indicated that physical improvements following the research intervention were accompanied by improvements in psychosocial domains and consequently expressed in enhancement of the children's general QOL. These findings were also confirmed, at one year after treatment terminated. The next chapter, Chapter 5 will discuss these findings and their correlation with the relevant research and theoretical literature reviewed in Chapter 2 in light of the research aims.

## CHAPTER 5: DISCUSSION OF THE FINDINGS

### *Precis*

The previous chapter described and explained the quantitative and qualitative findings of the research. Quantitative findings clearly showed that all participants improved their at-rest-reach free sitting, balance, ADL functioning and their level of PC. Qualitative data supported these findings and testified to improvements in children's sitting and ADL functioning skills, enhanced psychosocial status and family dynamics and behaviour and QOL (maintained for a one-year period).

### **5.1 Introduction**

Guided by the RQs, the research aimed to investigate whether an innovative PIA could improve the adaptation of children with CP as depicted in the conceptual framework of the research (Figures:1-4) and thus produce improvement in their QOL. The discussion considers both quantitative and qualitative findings collected to adequately answer each RQ. It explains, compares and analyses the findings in light of the theories, research methodology, and methods discussed in previous chapters, engaging with these authorities in order to question the present research findings in the context of the particular field of knowledge.

This study conducted RCPWB in a sequence of phases in order to offer an alternative PIA environment using an innovative TTC. The technology and resources that were developed enabled the children with CP to undergo a graduated adaptation process which was offered as a therapeutic intervention. The aim was to improve the motor adaptation and functioning of children with CP, enabling them to increase their psycho-social development, which would subsequently enhance their QOL. It was hoped that the results of this intervention could also contribute to extant knowledge and theories in the relevant fields.

## 5.2 Discussion of the Findings relating to Research Question 1

How and why did the posture and balance abilities of participants with CP change during free sitting on land, after the PIA intervention?

### 5.2.1 Improved Posture and Balance during Independent Sitting on a Stool on Land

#### A. Quantitative Findings for RQ 1

The improved sitting of the participants was also supported by data collected from the quantitative methods. As explained in the previous chapter, validity of these data was enhanced by four types of triangulation (see Tables 10, 11, 13 and 5: Tools Nos. 3,4 and 5).

According to the quantitative findings: **All participants displayed a great improvement in quality of free sitting at-rest and balance. PIA water treatment was found to be most efficient in producing these results. Highest results of intervention were those produced by water and land treatment together, while lowest results were produced by the land intervention treatment alone.**

#### Goniometry Measuring Tool

All participants displayed a large improvement in at-rest free sitting and balance. The most significant finding was an improvement in passive and active ROM of hip flexion in AT. Those results accord with results of other studies: Shelef, (1998; 2000; 2002) and regarding knee extension, Fragala-Pinkham et al. (2009). They also tally with the definition of improved free sitting quality and balance by Reid (1997, p.4; Russell et al., 1993), explaining that an increased ROM should indicate better sitting balance. As seen in Appendix 23: Goniometry Results, Summary Table 1, there are 41 (80 percent) positive goniometric results for ROM of hip flexion, and 10 negative results (20 percent). Chapter Four: Findings, Graph 1, also shows clear positive results for treatment in all three intervention environments employed. **These findings from the Goniometric instrument concerning improved ROM and sitting adaptation (enhanced by triangulation), are unique and support the innovative application of the Goniometric measurement strategy in such research.**

Improved sitting following the PIA can be explained as the result of the two intervention treatments: SPT treatment, and ADLSF. Both treatments were developed from the various theoretical principles and practices discussed in Chapters 2: Theoretical Perspectives and 3: Methodology. These conceptual foundations formed the basis for therapeutic strategies that applied the concept of '*movement and posture*' (MP) to children with CP (Bax, 1964, pp.295-296; Rosenbaum et al., 2007a). In order to improve the children's MP, the specially

developed PIA interventions employed SPT and ADLSF strategies, with the integration of the following concepts: In sitting position when ROM of the hip flexion joint increases during trunk flexion forward with the free ability to return to straight upright sitting position, this indicates that balance and posture have increased; the importance of rotation to rehabilitate sitting of people with CP (Bobath, 1967; 1971a; 1984); the concept of PNF diagonals (Knott, 1967, Mitchell and Ogden, 2002); use of an independent flat sitting surface base without support (Cotton, 1965; 1970; 1974; Howle, 2004); maintenance of the child's legs posture as close as possible to a 90° angle at hip, knee and ankle joints (Reid, 1997); functions of ADL (Goldstein, 2004; Mayston, 2004); rhythmical intention (Schenker, 1994; Taylor et al., 2007); AT and water principles including heat (Becker, 1997; 2004; Vargas, 2004) and PIA (Harrison and Bulstrode, 1987; Fowler, 1997), using TTC aiming to improve MP adaptation (Howle, 2004; Feuerstein, 2007).

The above-mentioned findings can be interpreted in the light of the underlying theories of DST and CNS used with other theories to construct the conceptual framework.

Dynamic System Theory (DST) was used *'to determine which parameters [system] are dominant and which are able to be manipulated [system change] to improve motor outcome'* (Deitz Curry, 1998, p.300), in the present research RCPWB was the dominant and manipulated system. Bernstein (1967) suggested that 'degrees of freedom' enable system change; RCPWB simulated 'reduced gravity' conditions in PIA that enabled progressive adaptation by generating reorganisation of systems to produce new forms of behaviour (Thelen and Ulrich, 1991; Smith and Thelen, 2003; Howle, 2004).

Similarly, CNS theory regarding the plasticity of human adaptation (Lombroso and Ogren, 2009; Shalev, 2009) indicated that an enriched environment positively affects an individual's condition before and after human pathological lesion and the recovery process, supporting the research assumption that regulation/control of this environment could enhance adaptation (Byl, 2003; Bobath, 1980 in Howle, 2004). **This regulation seems to have enabled participants to improve their skills in water and gradually transfer these skills transferred to land.**

#### PIA Water Treatment constitutes the most Efficient Intervention (Goniometry Tool)

Chapter 4: Findings, Graph 1 indicated negative results for the treatment of Avi and Maor on land. The explanation seems to lie in the fact that the variable of the heated water environment benefits the hips' ROM better than the conditions of the land environment. Campbell (1955); Grobaker and Stull (1975) and Alter (1996) support the beneficial effects of hot water and packs to increase joints' ROM with average non-disabled population. PIA

in Water was shown to be the most efficient intervention environment (Table 14) in terms of mean time per improved ROM (Input/Output). This accords with findings of Peganoff (1984); Shelef (1998) Vogtle et al. (1998) and Fragala-Pinkham et al. (2009) relating to AT work with people with CP.

**The findings indicated that treatment for children with CP in AT with the recommended water temperature of 33.3-35° C (Dull and Schoedinger, 2004) produces a definite benefit, retaining heat and transferring heat energy (Becker, 1997; 2004; Vargas, 2004).** It facilitates tissue elongation, relaxation and therapeutic learning which may explain the increased ROM of hips flexion for the children with CP which consequently produced improved sitting balance (Reid 1997).

These results echo the assertion of Fragala-Pinkham et al., (2009) that: *'Balance activities with water at varying water depths can be used to work on balance'* (p.76), due to the uplifting force of water-buoyancy. Adding heat to PIA environments apparently affected *'functions involved in regulating the core temperature of the body'* (WHO, 2007, p.87), demonstrating *'what can be done to the environment of the individual to improve performance'* (p.243).

PIA in combined water and land treatments produced the most beneficial results(Goniometry, SACND-(rest) and IRO Tools)

Triangulated findings indicated that the use of PIA in a combination of water and land environments produced the most beneficial results, applying the motor adaptation paradigm. This paradigm was adopted because *'Models of motor control in NDT [show] that these theories account for the variability and adaptability of motor behavior in a variety of environmental conditions [water and land] during development and during recovery from neuropathology'* (Howle, 2004, p.65).

The combination of environments provided the most effective milieu to improve the condition of the children with CP (Becker, 2004) but with the highest number of treatment sessions. Other AT approaches that recognised the benefits of combining both of these environments for rehabilitative therapy include: the HA (Cunningham, 1997; Lambeck et al., 2004), TTTA (Morris, 1997), Orthopaedics (Lee, 1998) and rehabilitation with aqua-running (Wilder and Brennan, 2004). Also, Vargas (2004) and Fragala-Pinkham et al. (2009, p.76) sources indicated that *'a combination of land-based and water-based intervention would assist with carryover of functional mobility skills on land'*.

These authorities suggest that the care-giver should verify the load in water and in land environments when combining both during treatments (Harrison, 1980; Harrison et al., 1992; Lee, 1998). The contribution of the current research to this field is the development of a more precisely measured load since the manipulation of the TTC to RCPWB an

increase in load by 30mm at each phase of the therapy (compare with Appendix 2: Figures: 2, 6 and Figure 11(2-11)), enabled the researcher-therapist to regulate different loads and their effects on the hips flexion-ROM.

**The use of this technique in both environments (land after water) proved the most beneficial milieu, improving quality and balance of at-rest free sitting and the consequent findings were unique to this research.**

Land treatment was the least effective intervention for improved ROM (Goniometry Tool)

Goniometric findings regarding the lesser improvement of hip ROM during passive and or active flexion, after PIA intervention on land correspond with goniometric results in other studies on land interventions for people with CP (Stuberg, et al.,1988; Witt and Parr, 1988; Holland and Steadward, 1990; Akbayrak et al., 2005; McDonald and Surtees, 2007), and in AT studies relating to passive ROM therapy (Vogtle et al., 1998; Shelef, 1998; 2000). The results of two studies that employed identical land conditions to the present study exhibited less improvement e.g. Witt and Parr, 1988, p.93, Table 2: Total mean of passive and active ROM of hip flexion is 5 degrees; Holland and Steadward, 1990, p.30, Figure 3: (Hip abduction), total mean of passive and active lower body ROM is 2.35 degrees. This may be compared with the present study achievements presented in Graph 1: Total mean of passive and active ROM of hip flexion is 9 to 10 degrees. However, **the present study showed that PIA in AT produced better results for hip flexion-ROM than the present land intervention and the land interventions of these previous studies. Indeed, in the present study the lowest improvement of ROM was accomplished by the PIA treatment on land.**

Investigator Triangulation of Quantitative Findings from Observations with SACND-Rest Module Sitting and Findings from IRO (Table 10: RQ 1)

The findings from SACND and IRO are discussed together because they were both used to evaluate the at-rest posture of the research participants using direct observation techniques (Angrosino and Mays de P'erez, 2003; Yine, 2003; Morse, 2006; 2007a; 2007b). They enabled the researcher to *'gather "live" data from "live" situations'* (Cohen et al., 2000, p.305).

The positive improvement of at-rest free sitting and balance registered by both observation methods (Graphs 2 and 3) seems to justify the emphasis given to the head position in the treatment interventions of this research. This strategy relied on the conceptualisation of Twitchell (1954) who contributed to NDT, PNF (Pope-Davis, 2001), Movement Therapy (Brunnstrom, 1961; 1970), and the Neurophysiological Approach (Huss, 1988), by suggesting the importance of the correct development of posture of neck, head and body righting to form a stable, proper position (Bobath, 1984; Pellegrino and Dormans, 1998;

Yamamoto, 2000). The emphasis on the head position also included application of developmental approach principles that see vision or the eyes' view as helping to guide the head position, a process then followed by motional responses such as: arms, legs and total body movement (Scherzer and Tscharnuter, 1990; Jegasothy, 1998; Pope-Davis, 2001). DST also suggests controlling the head for better reaching (Thelen and Spencer, 1998).

A functional conceptualisation presented by Bernstein (1967) is based on synergetic or functional muscles' movement units which, together, form a '*coordinative structure*' (Zernicke and Schneider, 1993); an example being the achievement of efficient chest movement that affect the functional physiological task of inhalation and contribute to the coordination of head stabilisation (Howle, 2004).

AT approaches also underline the importance of the head in treatment in a water environment: HA (Cunningham, 1997; Campion, 1998f; Lambeck et al., 2004; Morris, 2004; Vargas, 2004), Shaw method (Shaw and D'Angour, 2005), Jahara technique (Brunschwiler, 2007), and PAT, (Peterson, 2004, p.239). The specific amount and frequency of intervention (load) applied for participants in the present study was guided by the basic principles of the CE treatment approach as explained in studies describing the CE day schedule (Cotton, 1965; Cotton and Parnwell, 1967) that also indicate the importance of the head in rehabilitative therapy. **However the amount (Load per Week and per Study: Hutzler, 2009) of treatment in the present study that was found to be effective in producing improved sitting extended beyond the boundaries of previous practice in this area (Table 1).**

The findings regarding the positive improvement of at-rest free sitting and balance also suggest that applying an adaptation paradigm by providing several gradually changing environments for treatment, improves the child's adaptation process as was suggested by the following approaches NDT (Howle, 2004), CE (Hari and Akos, 1988), in various domains DST (Thelen and Ulrich, 1991; Thelen, 1995; Smith and Thelen, 2003); Family Centred Services (FCS) within the EA (Tieman et al., 2004; Palisano et al., 2004; Sugden, 2007) and PSE and empowerment: SCT (Ozer and Bandura, 1990; Bandura et al., 2001; 2003). **The finding regarding improved free sitting and balance was expressed by an improvement in motor adaptation which triggered an improvement in other adaptation domains indicated in the conceptual framework of this study. This finding is unique to this research.**

The findings, presented in Graphs 2 and 3 (Chapter Four: Findings), show an obvious positive improvement of at-rest free sitting and balance in all three environments i.e. water, water and land, and land. These findings resemble findings relating to improved sitting

produced by other land treatment approaches: NDT alignment (Edwards, 2004; Howle, 2004), postural control (Alexander, 2006; Hadders-Algra et al., 2007), treatment of balance by NDT (Scherzer and Tscharnuter, 1990; Tscharnuter, 1993; McNeill, 2004), treatment of balance by CE (Cotton and Parnwell, 1967; Cotton, 1970; 1974; Sigafoos et al., 1993), improved sitting with NDT (Lewin et al., 1993; Reid, 1996; Hadders-Algra et al., 2007) and improved sitting with CE (Heal, 1972; Clarke and Evans, 1973; Reddihough et al., 1998; Lind, 2000). Both NDT and CE practice relate in a similar way to the present study, to the need to improve motor adaptation, taking into consideration demands for skills, the child's ability and experience, the type of task and environment (Howle, 2004; Taylor et al., 2007; Ben-Pazi, 2009; Shalev, 2009).

#### PIA Water Treatment is the single most efficient Intervention

Triangulation of quantitative data from Goniometry, SACND and IRO (see Graphs 1,2,3-the blue column-water interventions-Tables:14, 15) with qualitative descriptive data from NDFI (Table 10: Question 1: Between methods and Data triangulations) e.g. the category of *'improved sitting for a relatively long time'* (Table 11) demonstrated that **the PIA water treatment produced an improvement in at-rest free sitting and balance.**

Theoretical literature explains the effect of AT-water treatment on free sitting and balance according to two main principles: (1) The principle of the Aquatics Meta-centre Concept or Bougier's Theorem (Becker, 2004; Vargas, 2004). (2) The basic principle of the effect of shape and density of different humans' bodies in water (Campion, 1998g), *'A body suspended or floating in water essentially counterbalances the downward effects of gravity with the upward force of buoyancy'* (Becker, 2004, p.424). These principles were applied during immersed cube sitting position practice in the PIA intervention. The position complies with land-motor theories e.g. Re-education Model and AT: HA, WA, PAT and with head injuries-neurosurgical (Jegasothy, 1998, p.195) approaches.

The finding that PIA water treatment produced an improvement in at-rest (Reid, 1997), free sitting and balance is compatible with findings under similar conditions of the following studies (Harrison and Bulstrode, 1987; Harrison et al., 1992; Nakazawa et al., 1994; Fowler, 1997; Miyoshi et al., 2004) treating a non-disabled population in standing/walking to improve gross-motor positioning. These studies produced similar positive results with similar treatment approaches, however they are not entirely comparable to the present research, which related to treatment of the at-rest sitting of children with bilateral CP. Additionally the present research employed RCPWB which produced a more sensitive gradual reduction of immersion that gradually increased gravity load according to



participants' levels of motor adaptation a technique that was not employed in the previous studies.

**The positive findings indicating improvement of at-rest free sitting in this manner constitute innovative findings by the present study that contribute to extant knowledge in this field.**

Controlling the conditions of the AT environment for the benefit the children with CP (Hutzler et al., 1998a; Kelly and Darrah, 2005; Thorpe et al., 2005; Getz et al., 2007; Ozer, et al., 2007), enabled the children to improve their sitting capabilities in the different environments. The process by which this was achieved is explained by NDT:

*the child is able to modify sensory information and form new motor strategies in accordance to changing task and environmental conditions* (Howle, 2004, p.47).

These positive findings also appear to reinforce the validity of instructions indicated by CE 'Alter the environment so that a child achieves success in a task, rather than direct, manual handling' (Taylor et al., 2007, p.50). EA, also indicates that the environmental conditions have a major influence on the child's participation (Rosenbaum et al., 2008; Shevell et al., 2008), in home activities, school and in the community (Law et al., 1999; Darrah et al., 1999; McBurney et al., 2003; King et al., 2003; Palisano et al., 2004; Schenker, Coster and Parush, 2005).

### **5.2.2 Problematic Issues relating to the Cases of Manor and Avi**

In this particular context the improvement exhibited by Manor and Avi should be interpreted with caution and must be evaluated across the four RQ.

#### Manor-Research Participant

Quantitative findings from the observation-SACND rest module method (Graph 2) indicated that the PIA water intervention (shown in the blue coloumn) provided for Manor produced negative results. However, the evaluation of Manor's status according to two other tools (see Graphs 1: Goniometric measure-ROM, and 3: IRO-observation), exhibited positive at-rest sitting results following PIA-water intervention. This data was triangulated with qualitative descriptive data which also indicated improved at-rest sitting and balance skills. SACND-reaching module (Graph 4) presented negative results for Manor following PIA-water and water and land treatments. The other two tools that measured Manor's functioning abilities: the RSADLOT, indicated slight improvement in ADL hands' function (Graph 5) and an improvement was also recorded in the data gathered from the GMFM questionnaire (Table 18), but negative results were exhibited with regard to the sitting dimension.

These triangulated findings raised some debate regarding the amount and the types of Manor's PIA water intervention, i.e. the relative benefits of SPT, as opposed to both SPT and ADLSF-alternated treatment intervention. It is also noted that some scholars (Campion, 1985; Davis and Harrison 1988), cast doubts on the benefits of AT for children with CP, e.g. *'Unfortunately, there is a lack of evidence for assessing the potential merit and safe application of aquatic exercise for children with CP'* (Kelly and Darrah, 2005, p.841).

The clear positive factual results for Manor's PIA water treatment were the cumulative product of data triangulation of quantitative and qualitative findings (Table 10: relating to RQ 1 and 2), and interpretations of these data, which were expressed in conceptual findings (relating to RQ 3 and 4).

#### Avi Control Participant

The findings collected with the IRO method (Graph 3) for the PIA water intervention for Avi (control for Manor), indicated negative results. However, no PIA water intervention was provided for Avi. Logically, there should therefore be no difference in Avi's status between the pre-intervention and post-intervention 1 evaluations of treatment. An interpretation of this finding may be based on the fact that *'in children with CP, it is difficult to predict precise outcomes'* (Bower, 2004, p.33).

However, the triangulated findings for Avi showed a general improvement across the four RQ. The explanation for this unexpected result may be the fact that Avi received additional interventions outside the framework of the research. Avi's Physiotherapist, Alisa suggested that the result might be due to the fact that the year before the present study, another intervention had introduced Avi to the Hart-Walker (walking tool, which continued to be used during the present study). This tool may have had a positive effect on Avi's trunk strength and posture stability during walking (Schindl, Forstner, Kern and Hesse, 2000; Borggraefe et al., 2008), and increased walking distance. Both interventions (Hart-Walker and present intervention), as Alisa suggested, (and as evidenced in the qualitative data) enabled Avi to function better during and after the present intervention and this was evidenced in the highest total improvement that was recorded for the GMFM test (Table 18). There is therefore some limitation in interpreting Avi's findings but it is accepted practice in research concerning people with CP that participants maintain their individual treatments during the period of their participation in the research intervention (Hutzler et al., 1998; 1998a; Schindl et al., 2000; Day et al., 2004; Ozer et al., 2007), however undoubtedly this issue affected the study's interpretation.

PIA Water and Land Treatment produced the best results (SACND at-rest Module and IRO Tools).

The research used investigator triangulation of quantitative data produced by the SACND at-rest Module with data from the IRO (Table 10, RQ 1) to evaluate the at-rest posture of the child with CP using direct observation techniques. The findings following the AT intervention with PIA in combined water and land environments, which applied the carry-over principle, indicated an improvement in the quality of at-rest free sitting and balance. This achievement followed treatment supported by HA (AST, 1992; Cunningham, 1997; Lambeck et al., 2004) and PAT (Petersen, 2004); e.g. WA improved breathing skills, and this was followed by carry-over of learnt skills to land in full gravity conditions (Dull, 1997). Achievements due to TTTA using the specificity-of-training-principle were also carried-over to land activities under gravity conditions (Morris, 1997; 2004).

The explanation for this positive finding seems to lie in the fact that using both environments in conjunction with the improved PIA provided assisting environments for treatment (Zaino and McCoy, 2008), in which the therapist could control the gravity load (Harrison et al., 1992; Campion and FitzGerald, 1998) facilitating the child's practical experience of skills (Ben-Phazi, 2009; Shalev, 2009) and providing an opportunity to master ADL with gradual transfer of these achievements to the land environment conditions. A similar strategy is mentioned by the following approaches NDT (Edelman, 1987, Larin, 2000; Howel, 2004), CE (Clarke and Evans, 1973; Hari and Akos, 1988; Brown, 1997), and DST (Thelen, 1995).

Time triangulation (Table 10, RQ 1) of qualitative descriptions from-NDFI produced data relating to the '*improved upright position and sitting quality*' category (Table 11) and quantitative investigator triangulation of observations: SACND and IRO methods (see Graphs 2 and 3) provided evidence of improved free at-rest sitting and balance after water-unloading and land-loading treatment (brown column).

This finding led to the following practical conclusion: within the PIA (Harrison and Bulstrode, 1987; Harrison et al., 1992; Liao et al., 2007), **the use of the principle of unloading to loading proved essential for the stable sitting of children with bilateral spastic CP (GMFCS level IV, Palisano et al., 1997; Cans et al., 2007) an advantage that would not have existed with the use of the opposite principle i.e. loading to unloading (Lambeck et al., 2004; Borggraefe et al., 2008).**

### The Advantages of PIA in a Water versus combined Water and Land Environment

Findings relating to the results of combined water and land treatments, (which provided the largest amount of treatments and produced the best results) were compared with the findings relating to results of PIA water treatment alone (which aimed to produce the most efficient results with fewer treatments - total mean in tables:14, 15 and 17).

The findings were validated by 'between methods' and 'investigator' triangulations of data gathered from all quantitative tools for the three different types of intervention: PIA water, water and land, and land, in order to answer RQ 1 (Table 10). The relevant literature describes more positive-superior findings for effects of the PIA-water environment versus land environment: producing more free movement (Lepore et al., 1998; Kelly and Darrah, 2005), strengthening physiological systems and providing therapeutic rehabilitative conditions (Cureton, 1997; Becker, 2004). Motor learning theory indicates better ambulation function and ADL in water than on land - (WA), (Morris, 1997; Campion 1998c; Dull and Schoedinger, 2004), and HA indicates positive neurological reactions in water and benefit from the principles of body and fluid mechanics and hydrodynamics (AST, 1992; Cunningham, 1997; Campion 1998b), and '*off-loaded*' and/or graded elimination of gravity effects (Becker, 2004; Cole et al., 2004).

This superior finding for the PIA in Water environments seems to be the result of the exploitation of Archimedes' principle and the effect of upthrust of buoyancy enabling a reduction of the effects of gravity on the body parts in PIA in water (Harrison and Bulstrode, 1987; Harrison et al., 1992; Cole et al., 2004). These findings reinforce the scholarly opinion that the favoured '*aquatic environment, and particularly buoyancy, enables (CP) children to be more active .... These opportunities are limited on land because of gravitational constraints*' (Getz et al., 2007, p.226). The process was however completed and reinforced by verifying the use of the same skills and achievements on land after loading gravity conditions.

### Intervention on Land alone produces less Benefits for Free Sitting Posture and Balance

'Between methods' and 'investigator' triangulations of quantitative findings: (Table 10 relating to RQ 1) related to participants' sitting achievements in a land environment following PIA with a stool instead of the TTC but maintaining an identical body sitting position.

Data shown (in white column) Graphs 1,2,3,4 and total mean score following land intervention in Tables: 14, 15 and 17, indicated a lesser improvement following treatments on land in quality of at-rest free sitting and balance than following treatments in water. Negative results for Keshet's intervention on land (Graph 3) seem to be explained by the

absence of the benefits of water environment in land setting, e.g. heat and the hydrodynamic principles which assist balance, development of skills and rehabilitation (Campion, 1998b; 1998c; Becker, 2004; Vargas, 2004), since Keshet's achievements in water represented a dramatic leap forward in quality of sitting.

#### Horizontal Flat Sitting Surface with Legs Position

Triangulated findings indicating the improvement of sitting after PIA-water treatment; PIA-water and land treatment, and calculation of results for potential land treatment only, seem to confirm the conclusion of the land treatment study of Hadders-Algra et al (2007) that **a flat sitting surface (no incline or decline) is beneficial for children with bilateral spastic CP** (GMFCS level IV, Table 4, free sitting time), enabling them to improve their postural control and stability during sitting.

Additionally these positive findings seem to confirm other theoretical assumptions reviewed in Chapter 2: Theoretical Perspectives and employed during the present study: Dr. Phelps' Muscle Re-education, Neuro-Senso-Motor-Therapeutic (NDT,CE) facilitation and MCLT models using SACND method (Reid, 1997), AT approaches, using the Cube immersion position (Cunningham, 1997; Vargas, 2004) and CE (Cotton, 1965; 1970; 1974) indicating participants' positive improvement in a 'symmetrical sitting posture' (Taylor et al., 2007, p.55). These theories emphasised two principles: First, the need to sit on a flat sitting surface base position. Second, the hip, knee and ankle joints should be positioned as close as possible to a 90° angle (Reid, 1997) thus, enabling maintenance of the child's legs posture while sitting during treatment and evaluation. This fixed legs' position was mandatory on land and in water environments in order to equalize conditions under which the data was collected between environments and because it influenced the state of the base of support (correct legs' angle and legs positions i.e. heights, positioning etc.) and, centre of mass. These strategies all contributed to improving balance, postural control of: head, neck, extremities, trunk and pelvis alignment during functioning while sitting (Howle, 2004; Vekerd, 2007).

**These two principles were used by the researcher for the engineering, development and construction of the TTC with its mechanical legs support solution.**

#### **B. Qualitative Findings for RQ 1**

The qualitative findings that emerged from the interviews show an improved upright sitting position, and good quality of independent sitting for a relatively long time with no fear of falling (Table 11), for example '[She is now able]to experience her body in a positive, strong and stable way'. 'When he does this [uses the hand functionally], most of the time, he can maintain his

*sitting position'. 'The rotation that we saw, this is really stability within the movement or movement within the stability'.*

This finding can be explained by a change in four variables during and following the intervention. First, there is no longer any fear during sitting. Second, practice of free independent sitting without support. Third, the use of a flat horizontal base of support during sitting. Fourth, use of a new PIA treatment environment, RCPWB in order to improve motor adaptation using the TTC.

### No Fear

The intervention aimed to eradicate fear of falling during sitting for children with CP. Bobath and Bobath (1984), Howle (2004) and Young et al. (2007) all suggest that there is a connection between the impaired balance abilities of people with CP and their fear of being moved without support against gravity or falling. Observations showed that the children lose their sitting balance when reaching out for an object. This indicates that balance is an essential component of the movement synergy necessary for postural control (Bobath, 1971a; Bobath and Bobath, 1979) and so the maintenance of balance during sitting and motion has become an important treatment goal in order to improve adaptive functioning of the children with CP.

The dissipation of the children's fear that was evidenced in the interviews with the children and their surrounding adults can be explained in the context of the supportive AT environment. AT is very useful in managing neuromuscular impairment as it provides a protective safe environment, reducing pain, easing movement, and exploiting benefits of water properties: thermal effects, relaxation, weight relief. It is therefore most suitable for training and rehabilitation with a variety of learning experiences, creating a pleasant feeling (Campion, 1998c; Becker, 2004; Cole et al., 2004; Morris, 2004; Vargas, 2004).

Social Cognitive Theory (SCT) may provide additional explanation for the reduction of the children's fear of falling (William, 1987; Bandura, 1988). Bandura et al. (1975; 1977) claiming that the development of empowered efficacious coping and effective skills essentially eliminates phobic thinking, and decreases perceived vulnerability, threats and fearfulness (Ozer and Bandura, 1990). Thus the empowerment of the participants due to their achievements in the present interventions may have reduced their fears.

Although there is little literature on the reduction of fear in AT it has been shown that soon after birth infants have no fear of water; and also appear to have less fear of losing balance or falling in water (Campion, 1998c; Petersen, 2004; Fragala-Pinkham et al., 2009). This seems to indicate that AT may have the ability to reduce fear, which one of the *'specific mental*

*functions related to the feeling and affective components of the processes of the mind'* (WHO 2007, p.54). These affective components were enhanced in the intervention since *'synaptic connections become strengthened as we learn'* (Lombroso and Ogren, 2009, p.5). In the present research, qualitative data yielded a category of *'no more fear of falling'* during sitting (Table 11), indicating that the PIA interventions empowered the children with CP as they learnt skills, which increased their confidence and reduced fear. **This finding that fear of falling was reduced supports the innovative use of PIA for this purpose in the present study.**

#### Free Independent Sitting Without Support

Both the NDT and CE approaches argue that a bilateral spastic child with CP can learn to control balance without being touched or receiving assistance or any other interferences (Bobath and Finnie 1958; Cotton, 1965; Bobath and Bobath 1984; Scherzer and Tscharnuter, 1990; Scherzer, 1993; Hari, 1997; Howle, 2004; Rosenbaum et al., 2008) and that they should be treated with minimum or without any support during free independent sitting intervention (Reid 1995; 1996; 1997; Van der Heide et al. 2005; 2005a; Hadders-Algra et al. 2007 and Vekerd, 2007). In the present study, buoyancy provided the support of an appropriate upward force, when the child sat on the TTC, enabling the child to function without further support by the researcher/therapist. This was described in the qualitative-NDFI data that yielded the *'improved independent sitting'* category (Table 11).

In contrast to the NDT and CE approaches to sitting applied in the present study, other research studies have attempted to apply a sitting base in different positions of inclination or sloped angles, to improve posture with sitting and functioning (Brogren et al., 2001; Carlberg and Hadders-Algra, 2005; Van der Heide, Fock, Otten, Stremmelaar and Hadders-Algra 2005a). Yet other studies have advocated the child's sitting with different supports, other stimulations or customised chairs (Park, Park, Lee and Cho, 2001; DeLuca, Echols, Ramey and Taub, 2003; Holmes, Michael, Thorpe and Solomonidis, 2003; McDonald and Surtees, 2007; Chen and Yang, 2007). Following a review of the evidence from sixteen journal articles published after 1980 and reviewing their bibliographies for the effects of positioning on upper extremity function for children with CP, Stavnes (2006) concluded: *'with the exception of one study, most of the evidence states that seat angle does not affect functional abilities'* (p.40).

Practical suggestions drawn from the above-mentioned opinions were: first, the child with CP should be handled by allowing them the freedom to improve motor expertise for MP, and only securing them when absolutely necessary. Second, a flat seat base is recommended for best posture. These suggestions were therefore adopted in the TTC design and

construction for the intervention in water and the stool was used in the present study for land treatment and evaluations.

The present study contributes a new developed PIA approach to rehabilitative intervention and adds to extant knowledge regarding therapeutic consideration of inabilities to erect, indicating innovative strategies to help children with bilateral spastic CP to adapt better to their environment by correcting their sitting capabilities and consequently their functioning abilities. The present findings seem to uphold the Conceptual Framework assumption that the improved PIA could use buoyancy with significant healing effectiveness (Becker, 2004) to improve independent sitting during participants' independent ADL function in conjunction with improved HHC. This technique regulated the upward force of buoyancy that held and/or balanced the child's MP (Rosenbaum et al., 2007a) against effects of gravity (Rood, 1956; Bobath, 1984; Reid, 1997; Campion, 1998e; Thelen and Spencer, 1998; Morris, 2004; Maguire and Nanton, 2005; Hatta et al., 2007). thus reducing gravity (Miyoshi et al., 2004) and moderating its conditions to facilitate the disabled child's gradual adaptation to gravity conditions.

The PIA interventions had the following beneficial effects:

First, using warm water they reduced the child's hypertonicity (Bergman and Hutzler, 1996; Hutzler et al., 1998a).

Second, they employed an unloading towards loading tactic (Kelsey and Tyson, 1994; Thelen and Spencer, 1998; Becker, 2004; Alleva, Hudgins and Biondi, 2004; Fragala-Pinkham et al., 2009), performed '*with progression to more shallow depths*' (Morris, 2004, p.155), gradually increasing the '*gravity load*' (Becker and Garrett, 2004, p.207; Galea, 2004) which under these special conditions, helped the children to develop their motor adaptation to the challenging environment (Hari and Akos, 1988; Rosenbaum, 2003; Smith and Thelen, 2003; Rosenbaum et al., 2007; Van Eek et al., 2009).

**The concept of a gradual progression to gravity conditions, using RCPWB to stictly manipulate gravity conditions during the application of the developed PIA, with the participant seated on the specially designed TTC tool consituted a pioneer innovation of the present research.**



## 5.3 Discussion of the Findings relating to Research Question 2

How and why did the HHC used in functional ADL abilities differ for participants with CP during free sitting on land, after intervention?

### 5.3.1 Improvement of Motor Ability in conjunction with improved HHC

#### A. Quantitative Findings for RQ 2

As explained in the previous chapter, four types of triangulation (see Tables 10 and 18 and Graphs 4,5) were employed to reinforce quantitative findings and qualitative descriptions from the NDFI, producing a category: '*Improved independent functioning*' (Table 11) which was exhibited by all participants.

These findings showed that all participants demonstrated improved quality of independent ADL skills functioning in conjunction with improved HHC during free sitting (Ahl et al., 2005). Maor and Keshet showed greater improvement in ADL and HHC skills functions compared to Manor and Avi.

These findings are compatible with the view of NDT that treatment goals should focus on maintaining an upright position, using specific tasks-goals, and improving functional training (Ben-Pazi, 2009a; Hurvitz, 2009; Shalev, 2009). This includes facilitating a stable head, mobile trunk, and stable pelvis that enable better functional performance and ability to reach out (Brogren et al., 2001; Van der heide et al., 2005; 2005a; Stavness, 2006). CE also supports the view that treatment should enable self care-ADL, eating, hand skills, hands washing and grooming (Heal, 1972; Coleman et al., 1995).

This positive finding can perhaps be explained as a consequence of improved postural control (Pope-Davis, 2001; Howle, 2004; Gramsbergen and Hadders-Algra, 2005), developing the child's functioning by moving trunk and other body parts under postural control during and according to function-task, skill, and environmental demands (Reid, 1995; Howle, 2004; Alexander, 2006).

The clear improvement in functioning was also influenced by the facilitating seating conditions provided by the TTC. The child with CP may find it difficult to be active-adapt from a supported surface contact (Reid, 1995; 1997), while practicing alterations in physical functioning. Suitable contact is decisive in generating movement from this surface point in order to perform any function (Scherzer and Tscharnuter, 1990; Tscharnuter, 1993; 2002).

**The TTC used in the present intervention influenced the quality of the relationship between surface contact and the functioning capability of the child with CP, improving the generation of movement from this contact point. This technique and**

its positive effect are unique to this study and indicate the effectiveness of this particular PIA treatment.

### ***Sitting Findings from the SACND Reaching Module***

#### PIA Water Treatment constitutes an Efficient Treatment

'Time' and Data Triangulations (Table 10: Question 2) using descriptive categories derived from data from interviews (Table 11), and observations (SACND-reaching measures - Graph 4 and Table 17) show that PIA water treatment, produced an improved quality of ADL functioning skills that improved HHC. The positive outcome was achieved during free sitting by all the participants, excluding Manor, discussed earlier.

Although there are several ways to achieve improved quality of these functioning skills in PIA water such as: sitting on the therapist's leg, while using disengagement strategy to improve the balance skill in HA (Vargas, 2004), WA (Dull and Schoedinger, 2004), and PAT (Petersen, 2004), or as Morris (1997; 2004), which conducted similar activity in water with TTTA and BRRM, using a combination of buoyant supporting objects, to improve buoyancy and then gradually reducing buoyancy or using 2 chairs in the pool transferring the client between them with support of the pool wall. increasing the difficulty, by distancing the chairs one from another or increasing their heights; none of the above techniques has the sensitivity applied by the RCPWB of the present study, gradually and systematically decreasing immersion in steps of 30mm maximum to facilitate a controlled adaptation process.

The application of the Specificity of Training Principle used in the following approaches: NDT – (Howle, 2004); motor learning and performance (Winstein, 1991; Schmidt and Wrisberg, 2004); and in the concept of learning transfer (Schmidt, 1991) and in AT using TTTA (Morris, 1997; 2004), may also have contributed to the improvement in performing functional tasks of ADL activities.

The use of TTTA-Specificity of Training Principle together with PIA and TTC appears to have been an effective combination for greater treatment efficiency in water in contrast to water and land treatment and land treatment alone in the present study.

**This combination or mixed treatment strategy is presented as an innovation of this research.**

#### PIA Water and Land Treatment produced the highest positive results

'Between methods' and 'investigator' triangulations of quantitative data from Goniometry measuring ROM, observation-SACND-rest/reach and IRO findings (Graphs: 1,2,3,4 and

Tables: 14, 15 and 17) indicated that PIA in a combination of water and land-environments produced the highest positive results during free sitting for all the participants apart from the slight limitation concerning Manor, discussed earlier.

A similar finding by Hutzler et al., (1998 and 1998a), indicated significant improvement of skills for children with CP after combined water orientation skills practice and NDT land treatment. Although these similar research environmental conditions also produced positive results there was a difference and superior achievement in the present research which may perhaps be explained by the use of RCPWB, larger amount of intervention (load per week and per study Table 1), using the Specificity of Training Principle (Gentile, 1987; Higgins 1991 in Morris, 1997), and training exercises to improve ADL activity as in HA (AST, 1992) and using CE-Rhythmical Intention strategy both in water and on land (Taylore et al., 2007) during PIA intervention.

**For the child with CP, the combination of water and land environments facilitated gradual adaptation to land gravity conditions (Howle, 2004), *carry-over* to the locatiuon where the child lives and functions.**

#### Land Treatment produced the lowest results

Previous findings have shown an improvement of HHC in conjunction with enhanced functioning (Vekerdy, 2007) and with reaching (Hadders-Algra et al., 2007) following treatment on land. However, in the present research 'between methods' triangulation of quantitative results (from Goniometry measuring ROM, and observation-SACND-rest/reach findings see Graphs: 1, 2,4 and total land mean in Tables: 14,15 and 17) relating to the PIA intervention on land indicated that treatment solely in this environment produced less improvement of free independent sitting for all the participants than did treatments in other environments.

BRRM lists the beneficial advantages of AT in water over land treatment (Garrett, 1997; Campion 1998e; Gray, 1998; Campion and FitzGerald, 1998; Becker, 2004; Kelly and Darrah, 2005), and the differences between these environments may explain the low results for land-only treatment (Cureton, 1997; Jegasothy, 1998; Kelly and Darrah, 2005).

The poor finding regarding the land intervention, may also be partially explained by DST, which suggests that the effect of the infant's additional weight and mass due to growth, negatively affects the legs' action under gravity conditions (Thelen and Fisher 1982). The stimulation of adding weights or alternatively reducing wieght by submerging infants in water (Thelen, Fisher and Johnson, 1984; Thelen, 1995), may produce a gradual increase or decrease in legs functioning according to the choice of predetermined stimulation (Thelen

and Ulrich, 1991). In water, 'short-cuts' can more easily be made in the control of physical mass by stimulating and manipulating long-term change in the development of legs' action (Thelen, 1995).

The fact that the lowest results were achieved on land, may stem from the fact that land lacks the effect of decreased mass (Cole and Becker, 2004; Miyoshi et al., 2004), unloading-open chain (skill) exercises, that are practical in the meliorated environmental conditions of water, cannot be achieved effectively in land treatment. In water, the PIA used RCPWB provided by the TTC to facilitate any MP with both types of chain-close and open exercises, according to the child's adaptative abilities. Although similar strategies were, applied in other PIA studies (Harrison and Bulstrode, 1987; Harrison et al., 1992; Nakazawa et al., 1994; Fowler, 1997; Campion, 1998e; Becker, 2004), in the present intervention the employment of the developed PIA with the special TTC was then carried over to land without a specific mechanical facilitation, an innovative method that improves upon these previous strategies.

The theory of human movement routes, used by NDT, CE, MCLT, DST and AT approaches developed from the classical hierarchical model described by Jackson (1932; 1958) and Sherrington (1947), seeing the CNS 'hard-wired' management as controlling all body systems, These are two distinct and separate processes: voluntary control (high level) and reflexive control (low level) of CNS. These concepts can be applied to understand the present research process within the theory of the Black Box Model coined by Pavlov (in Hari and Akose, 1988; Croce and DePaepe, 1989) also known as IPT (Schmidt, 1991; 1992).

The IPT, a basic part in MCLT suggests that the inferior effect of land environment intervention demonstrated here, reflected the influence of the extrinsic environment on the intrinsic organism. The present study extends knowledge in the application of IPT to AT since the use of the PIA and TTC in the AT environment increased the control and, regulation of the process of feedback (Closed Loop) (Smith and Thelen, 2003; Howle, 2004; Getz et al., 2007) improving stimulation of the Basal Ganglia Nuclei which control, evaluate, initiate, maintain and provide correct feedback following more effective movements-(Open Loop) (Kaplan, Sadock and Grebb, 1994; Sadock and Sadock, 2007) in this case in children with bilateral, spastic CP. **This strategy enabled the children with CP to improve their adaptation to the extrinsic environment even in other fields/other sub-systems. This process was less effective on land. This application of the Black Box model and IPT to the field of CP rehabilitation in AT (accomplished with the use of a specially developed PIA) is a conceptual contribution by this study to this corpus of knowledge.**

In parallel, this finding that treatment in the land environment produced the lowest results may also contribute to knowledge regarding Feed-Forward anticipatory adjustments of planning (Howle, 2004; Palisano et al., 2004; Chen and Yang, 2007; Stackhouse et al., 2007) produced in the cerebellum and activated some milliseconds before planned movement, which modulates the tone of muscles by predicting the amount of contraction needed for smooth motion (Sadock and Sadock, 2007). Several studies suggest that people with CP have sensory disturbances that detrimentally effect updating of achieved change to contextual states (McBurney et al., 2003), which causes difficulty in planning any Feed-Forward action (Gordon and Duff, 1999; Wolpert and Ghahramani 2000; Stiers et al., 2002; Steenbergen and Van der Kamp, 2004; Chen and Yang, 2007). Similarly, preterm children exhibit difficulties in sensory information processing of Feed-Forward, causing delay in development of visuo-manual coordination and therefore need more time for this process to become efficient (Sagnol et al., 2007).

Another option might be that children with CP have slower arm movements resulting from increased trunk compensation (Ricken et al., 2007). This intrinsic systems input-feedback, need correction, affects human and then expressed in output-Feed-Forward (Open loop), returning to environmental (extrinsic) variables and these in turn influence new input (Schmidt, 1991; Connolly and Montgomery, 2003; Howle, 2004). When people with CP execute reaching, they create Feed-Forward movement in the water-pool, however the outcome is slow (AST, 1992; Campion, 1998e; Morris, 2004).

Similarly on land, during infant development, hand reaching is also based on the slow-down of movement (Thelen and Spencer, 1998), enabling the infant with CP to use an adaptive strategy of 'extra time' to develop movement capabilities (Ricken et al., 2007). This understanding has led to a 'domino reaction', since several studies connected anticipatory postural adjustments with gravity (Crenna, Frigo, Massion and Pedotti 1987; Pedotti, Crenna, Deat, Frigo and Massion 1989).

As noted previously AT-water provides the benefits of diminished effects of gravity, consequently improving balance training and posture awareness (Vargas, 2004). This outcome improves independence (Campion, 1998c), security (Campion, 1998d) and functional ability (Campion, 1998e; Becker, 2004). This effect is absent on land.

To conclude the children with CP benefitted from the PIA with the TTC in three ways. First, the AT- water environment extended the reaction time of the disabled children allowing more time for feedback (Closed Loop) or anticipatory adjustments within the increased viscosity and hydrostatic pressure of the water environment, both producing resistance to movement (Cureton, 1997; Campion, 1998e; Getz et al., 2007).

Second, the ability to reduce gravity conditions in PIA (Mihoshi et al., 2004), and then through RCPWB, gradually decrease buoyancy in steps of 30mm and gradually increase gravity conditions enabled the therapist to control and regulate feedback to some extent.

Third, these two factors, (extra time for feedback and RCPWB) enhanced 'feed-forward' and consequently improved behaviour (Byl, 2003; Brown, 2004; Howle, 2004) in PIA. **Since the PIA water environment facilitated regulation over the Closed Loop and thus produced greater control of the Open Loop it was able to provide a more effective treatment milieu than land where this process was not possible. This understanding is presented as a contribution to knowledge in this field.**

#### Findings from the Rating Scale ADL Observation Test (RSADLOT)

'Investigator' triangulation of quantitative findings (indicated that participants Maor and Keshet showed better improvement than Table 10, RQ 2 and Graphs 4: (SACND-reach) and 5: (RSADLOT) Manor and Avi in HHC when performing ADL functioning skills during free sitting. The RSADLOT tool innovated by this research was used to measure the influence of the total intervention i.e. 'pre-post intervention' (King et al., 2004, p.82).

The data presented in Graphs: (4, 5) support the underlying assumption of the present study, indicating that improving posture control in sitting and balance of the body (RQ 1) also improves reaching and upper extremities function (RQ 2) (Bobath, 1971a; Bobath and Bobath, 1984, Alexander, 2006).

The finding that the later combined intervention for Maor and Keshet including both SPT alternated with ADLSF strategies produced a more positive improvement than was achieved by Moshe, Manor and Avi who only received SPT, accords with similar findings presented by NDT ((Bobath and Finnie, 1958; Bobath, 1984; Scherzer and Tscharnuter, 1990; Howle, 2004; Ricken et al., 2007) and CE (Cotton and Parnwell, 1967; Cotton, 1970; 1974; Brown, 1997). The advantage of the combination of these two treatments is that each enhances the work of the other enabling the participant to sit freely with greater HHC during the performance of ADL functional skills (Howle, 2004; Alexander, 2006).

It therefore appears that the underlying research assumption concerning the implications of improved posture control was not supported and the difference in the findings for the two types of intervention can be explained as follows. Improved sitting is not due to an SPT that improves posture, which then improves functioning or alternatively improvement of functioning that leads to improved posture, i.e. ADLSF-improving upper extremities functions enhances trunk and sitting posture,. Rather, **both strategies need to be simultaneously and interdependently improved and mixed; this is considered most**

**effective (researcher's interview with Dr. Alexander, 31<sup>st</sup> May, 2006); with the focus on the child's abilities, situation and skills (Howle, 2004). Since this was the strategy employed for Maor and Keshet, their results were superior.**

#### Gross Motor Function Measure Manual (GMFM)

As explained in the previous chapter, four types of triangulation (Table 10: Questions:1,2) comparing qualitative NDFI evidence indicated that all participants improved their total functioning abilities. e.g. the '*improved quality of hands function when sitting*' category (Table 11) with quantitative data (Graphs:1,2,3,4,5), clearly indicating improved motor abilities and HHC.).

Use of the GMFM evaluation method is supported by other studies that used people with CP following intensive goal oriented therapy and periods of no therapy (Bower, McLellan, Arney and Campbell, 1996; Bower et al., 2001; Trahan and Malouin, 2002), Adeli suit and NDT treatment (Bar-Haim et al., 2006), improved postural sitting (Brogren et al., 2001); and to test efficacy of CE (Reddihough et al., 1998) and AT intervention (Thorpe and Reilly, 2000; Fragala-Pinkham et al., 2009).

EA (King et al., 2002; Elder et al., 2007) suggests, that the proper mix of applied treatment theories and approaches of rehabilitation, e.g. Rhythmical Intention, Task Oriented Approach, Task Series-land and AT-water approaches incorporated within a cohesive PIA enables the therapist to use both land and water environment to improve '*functional adaptation*' (Rosenbaum, 2004; Ben-Pazi, 2009a) of motor abilities.

Improved motor functioning and HHC found in the present study appears to be explained by the use of a different synthesis of several treatment theories and approaches, including: Rhythmical Intention derived from CE (Cotton, 1965; Darrah, Watkins, Chen and Bonin 2004), which facilitates activity in water, (Campion, 1998f) and was linked to exercises based on the Task Oriented Approach (Bobath and Bobath, 1984; Howle, 2004; Ahl et al., 2005), known in CE as 'task series' (Cotton, 1965; 1970; 1974; Maguire and Sutton, 2005). These strategies were applied together in an AT environment following disengagement principles of HA (AST, 2002; Lambeck et al., 2004); relaxation and decrease in muscle tone from WA (Dull and Schoedinger, 2004); BRRM facilitation and inhibition with PNF diagonals (Mitchell and Ogden, 2002; Vargas, 2004); task specific TTTA (Morris 1997; 2004), HHC incorporated with the practice of ADL skill (Bobath, 1971a,b,c; 1972; 1974; Alexander, 2006), with acquisition of motor skills and predetermined task goals (Trahan and Malouin, 2002; Ahl et al., 2005; Wright, Rosenbaum, Goldsmith, Law and Fehlings, 2008). The regulated PIA environments provided an appropriate milieu to facilitate the application of

this mix of strategies in order to '*achieve appropriate adaptation to the task demands*' (Taylor et al., 2007, p.52).

This is supported by EA (King et al., 2002; Elder et al., 2007) which suggests that the proper mix of applied treatment theories and approaches of rehabilitation, incorporated within a cohesive PIA enables the therapist to use both land and water environment to improved '*functional adaptation*' (Rosenbaum, 2004; Ben-Pazi, 2009a) of motor abilities.

**This particular integration of different therapeutic strategies is presented as an innovation of this research.**

The qualitative descriptive findings indicated an improvement of independent physical skill ability combined with improved HHC when performing ADL during independent sitting for all CP participants, so that participants were enabled to focus on reaching out with no fear of falling while free sitting.

This finding was expressed in the qualitative category '*Improved HHC in performance of ADL skills*' derived from the NDFI e.g. (Table 11), supported by interviewees' expressions such as: '*He sits upright, when he brings his hands to his mouth, then he straightens up... Since the Researcher straightened his back, he simply eats better... because he sits upright*'; '*And this is an improvement! .... The ability to sit on a stool, to reach out with his hands*' and '*He wants things...[and says] "I want to eat alone", "I want [to do it] alone" [with wonder] He took the swimming goggles off by himself. He actually took them off all by himself*'.

Although it is impossible to directly point to the elements of the treatment that brought about these dramatic improvements it is possible that the employment of the following well-tried traditional principles contributed to the positive results: Cephalo-Caudal, Proximal to Distal principles (Bobath, 1984; Brogren et al., 2001; Lennon et al., 2006); fixation principles of NDT (Bobath, 1971a; 1971b), CE (Cotton, 1965; Cotton, 1974), and engagement/disengagement principles including distal movement, recognised by the following AT approaches: HA (Cunningham 1997; Morris, 1997; Campion, 1998f; Vargas, 2004), BRRM (Campion, 1998g; Morris, 2004), WA (Schoedinger, 1997 in Dull and Schoedinger, 2004) and TTTA (Morris, 1997; 2004). It was decided to rely on these somewhat aged traditional principles since they are supported and adopted by all land and AT approaches chosen for this study and because the innovative treatment conceptualisation of this study relied on the paradigm of motor adaptation, which is based on those principles and because the progression of the RQ (1 to 4) followed a sequence from the stabilisation of posture to improvement of upper extremity function, leading consequently to an improved PC and eventually an improved QOL (Figure 2).



More recently, NDT has focused on DST and on the functioning of sub-systems, asserting that the precision and quality of task performance depends on maturity of the systems (Thelen, 1995; Smith and Thelen, 2003; Howle 2004; Schonert and Thelen, 2006; Personal communication Capelovitch, S. 15<sup>th</sup> October, 2009). DST suggests that behavioural processes should be developed and followed however it does not offer clinical directives for rehabilitative treatments e.g development of: Cephalo-Caudal or Proximal-Distal directions, fixation, facilitation and disengagement principles. Nevertheless today, the new DST looks for the dominant system which changes other systems in order to improve behaviour (Deitz Curry, 1998). **In the present study RCPWB was identified as the system that created and enabled system change, which improved motor adaptation thus leading to an improvement in psychosocial intrinsic systems and consequently enhancing the QOL of the children with CP.**

The category: *'no more fear of falling'* was also derived from qualitative data (Table 11) For example, after the intervention in an interview with Manor: The Researcher: *'If someone wants to give you a cup of tea, do you want to sit on a stool or in the wheelchair? Where do you want to receive the tea?'* Manor: *'On the stool'*, in other words, without a backrest; and *'I didn't see that he was afraid, and he could do it'* and *'To experience her body in a positive, strong and stable way'*.

These findings correspond with previous research that demonstrated that the improvement of independent free sitting and physical functioning skill abilities reduces fear of falling. CE indicates that this process involves pedagogic guidance which gradually and purposefully builds the participant's confidence, enabling the therapist to teach functioning skills such as independent problem-solving, enhancing the child's initiative and autonomy (Shields, 1989; Sigafos et al., 1993; Stanton, 2002; Maguire and Sutton, 2005), and leading towards the ultimate goal of development of general adaptation: an *'orthofunctional personality'* (Hari and Akos, 1988, p.142).

Similar phenomena of successful adaptation were found by Stamm et al. (2008) with elderly participants with Rheumatoid Arthritis, who *'described their life as 'mastering' their disease'*, (p.665). This concept of 'mastery' relating to sitting skills was echoed in the present research participants remarks: After intervention, Researcher: *'Now, when you sit, are you afraid to fall?'* Manor: *'No!...but before yes!'* and formed the basis for their new confidence and seems to have contributed to the disappearance of the 'fear of falling'.

Reducing gravity (Farley and McMahon, 1992) through RCPWB enabled the researcher to facilitate the improvement of the participants' sitting posture and thus enabled them to improve upper extremities functioning with HHC during ADL. **The finding that this sequence produced the reduction of fear of falling and improved functioning is in**

line with the goals of the following approaches: NDT (Bobath, 1963a; Tscharnuter, 1993; Myhr et al., 1995; Reid, 1996) and CE (Titchener, 1983; Shields, 1989) amplifying the knowledge of both these schools of thought, since it provides a new conceptualisation: gradual environmental change to facilitate gradual adaptation to gravity and a new effective tool and strategy to implement this conceptualisation.

*'Adaptation to environmental changes'* (Boyd, 2004, p.54). is also suggested as a goal by MCLT which notes that environmental conditions affect the adapting person's behaviour and responses (King, 1978). In this context, Schmidt (1991), Gentile (2000), and VanSant (2003) indicated the need to control a combination of 'open' and 'closed' environments during the process of skills learning. The present research did just this, using RCPWB in a PIA with the TTC to facilitate the child's motor coordination and skills learning: for example to bring a tooth brush to mouth and then enabling the child to achieve the same task under increasingly difficult conditions as the child was gradually raised in the water toward land.

This strategy also corresponds with the assumptions of the two underpinning views chosen as the foundation for the present research. Firstly, NDT as espoused by Howel (2004):

*This model acknowledges that the extent of physical disability cannot be determined solely by intrinsic neural and body factors, but takes into account the effects of the environmental context (extrinsic variables) on the disabling condition'* (p.85, also see Table 21 p.84).

This extrinsic environment enhanced by the PIA strategy introduced the environment to the child with CP using adaptation regulation that was far more gradual than practised in other studies (Harrison and Bulstrode, 1987; Harrison et al., 1992; Nakazawa et al., 1994; Fowler, 1997; Becker, 2004), allowing the researcher-therapist to examine *'the extent to which an environmental factor is a facilitator or barrier'* (WHO, 2007, p.10).

Additionally, the finding that motor functioning improved as a result of this strategy is in line with two fundamental concepts described in the WHO, ICF-CY (2007, p.10-Table 1. and p.17 - Model of functioning and disability): firstly, to enable people with activity limitations to function independently and secondly contextual and extrinsic environmental factors determine intrinsic individual body factors (Howle, 2004; Ricken et al., 2007). The qualitative findings from the interviews, e.g. Physiotherapist: *'I was astonished when I saw him using his left hand and right hand separately'*. Moshe described: *'I understood that in fact this treatment, [PIA] this is what helped ... I learned that this was true'* show that when both these goals (improving environmental conditions and enabling people with activity limitations to function independently) are fulfilled the therapeutic process had positive implications for the children's improved motor functioning.

Following the interpretation of the data relating to RQs 1 and 2 the researcher moved on to examine parts of the children's intrinsic systems extending the quantitative and qualitative research to investigate the assumption that improved motor adaptation led to adaptation in other intrinsic domains and to improved QOL, in answer to RQ 3 and 4.

## **5.4 Discussion of the Findings relating to Research Question 3**

RQ 3: How and why did the perceived competence of participants with CP vary as a result of the intervention?

### **5.4.1 Improved Motor Functioning led to improved Psychosocial Functioning**

#### **A. Quantitative Findings collected in response to Question 3**

Three types of triangulation (Table 10: RQ 3) compared qualitative evidence from NDFI relating to dimensions of behaviour, social interaction, motivation, confidence, self-image, self-esteem and determination (Table 11: category parts) and quantitative data from the questionnaire-PSPCICCP findings (Graph 6) indicated that the participants dramatically improved their level of PC after the intervention treatment. The total mean percent of improvement for PC for all participants (difference between pre- and post-intervention status) was 17.65%.

This finding relating to the improved PC of the children with CP is in line with evidence of similar psychological benefits resulting from AT: e.g. improved self-concept for challenged populations (Wright and Cowden, 1986), reduced chronic back pain and improved well being (Landgridge and Phillips, 1988), ameliorations in juvenile rheumatoid arthritis accompanied by improved social stimulation, moral values and motivation (Bacon, Nicholson, Binder and White, 1991; Tinsley, 1998).

Appendix 8 Table 1, shows eleven AT studies that aimed to improve participants' self-esteem domains in comparison to the present study. This review reveals the difficulty in applying the conclusions of these studies to the present research, since they did not use mixed AT and land interventions as did the present study, although they also considered results of land function activities and their effect on GSW and PC domains in drawing their conclusions. Unlike the present study, these studies also included participants who did not have CP. Their methodology was either qualitative or quantitative, not the *'mixed method design...that can "pick up" what the first method missed'* (Morse, 2005; 2009, p.1524), used in the present study.

This finding that the children's PC improved is comparable with the child's ability to transfer symbolic play processes to improve real-life acting. Similarly, achieving competence in PIA allowed the present study participants to rehearse new skills for improved functioning (Wickes, 1966; Rubin et al., 1983 in Harter and Chao 1992) on land.

Many positive functions stem from the individual's intrinsic world: self processes, motivational functions, goals selection, action-plans and incentives toward self improvement. These processes act as protective mechanisms to achieve goals of more pleasure and less pain (Harter, 1999). Bandura (1969); Bandura et al. (1975) claimed that improved extrinsic functioning engenders positive intrinsic changes in attitudes and self-evaluation just as experiences of success reduce fear and improve self-competence. NDT claims that improved functioning leads to independence and therefore improves competence demonstrated in the individual's participation in community, family and personal activities (Goldstein, 2004; Howle, 2004). Similarly, CE indicated that establishing the child's independent activity is a fundamental element in an educational rehabilitation which aims to improve functioning, since independence motivates the learning process that enables successful adaptation to the child's natural and social environment throughout life (Hari and Akos, 1988; Sutton, 1988; Schenker, 1994; Campion, 1998c; Maguire and Sutton, 2005). The present interventions therefore aimed to improve competence and independence.

Drawing from these theories it seems that the AT-PIA used in the present study provided the necessary positive environment (Schmidt, 1991; Howle, 2004; WHO, 2007) to produce improved task and skills performance, independent ADL functions, a sense of success and improved motivation (Lipscher, 2009; Fragala-Pinkham et al., 2009) thus enhancing participants' GSW (Vermeer, 1992; Curdova' et al., 2001; Schuengel et al., 2006; Gorton et al., 2009), and PC toward the improved self-adaptation known as PSE (Bandura et al., 2001, 2003). This process empowered the children with CP to become active participants in their rehabilitation (Miller and Reid, 2003; Harris and Reid, 2005; Blank et al., 2008) improving their general functioning, which consequently increased their self esteem and self perception (Dorval et al., 1996; Thorpe et al., 2005).

Combined water and land-PIA intervention produced positive effects on self-processes (Harter, 1999) in psychological domains, in contrast to negative effects found in studies of other AT treatments (Hutzler et al., 1998; Ozer et al., 2007) thus, **the finding that there was an improvement in the PC of the participants with CP as the result of an AT- and land intervention is presented as a unique achievement of the PIA employed in this research.**

## B. Qualitative Findings in response to Question 3

Qualitative findings (Table 11) indicated improvement of participants' social integration, behaviour, motivation and emotional state expressed in improved self-image, self-esteem, self determination and success in the school environment. All interviewees indicated that free independent sitting achieved during PIA interventions improved the quality of their ADL skills function, enhancing motor adaptation which triggered improvement in '*diverse forms of adaptation*' (Bandura et al., 2003, p.779) in other domains as suggested by the general theories of behaviour underlying the conceptual framework of the present study.

### The finding in relation to theories relating to Land-based Therapy

The finding that improved physical functioning enhanced self-image and self-esteem is in accordance with theories concerning the attainment of 'competence'. Competence was defined by White (1959;1971 in Shannon, 1988 as the ability to '*interact effectively with the environment*' (p.147) and '*... to meet the demands of a situation or task*' (p.147). while Harter (1978 in Getz et al., 2007) claimed that PC is a domain-specific construct and children achieve competence according to each domain of ability (Hutzler et al., 1998; Schuengel et al., 2006).

This qualitative finding (Table 11) is also in line with the concept that PSE is the 'key' to empowerment and adaptation in SCT (Ozer and Bandura, 1990; Hutzler, 1990; Bandura et al., 2001, 2003), a principle also applied in child and FCS (Dunst et al., 1988; Rosenbaum et al., 1998; King et al., 2004), and in CE that emphasises the need to develop the child's personality as a pre-condition for successful adaptive development, motivation, confidence and self esteem through problem-solving, and task series, a component of Rhythmic Intention strategy (Brown, 2005; Maguire and Sutton, 2005; Taylor et al., 2007). NDT also stresses the need for a model of 'enablement' (Boyd, 2004) so that the child can cope with demands of the environment-ICF model (WHO, 2001; McBurney et al., 2003; WHO, 2007), acknowledges that physical disability is not only the product of the intrinsic neural body system (included the psychosocial-self) but is also influenced by the effects of the extrinsic-environment on the condition of the participant with CP (Howle, 2004).

### The finding in relation to Aquatics Therapy Theories

Qualitative-NDFI evidence (employing 'time' and pre/post intervention triangulation-) that produced the category of '*Physical motor success improves emotional state*' (Table 11) were compared with quantitative data (Graphs:1,2,4, blue column-water). The resultant finding indicated that improvement of motor function in water leads to psychological enhancement of GSW. This corresponds with theory and findings regarding the benefit of water for psychological functioning.

The ancient Greek, Hebrew and Roman civilizations recognised aquatics as a concept associated with psychosocial factors and renewal, cleansing the body of sin and disease and regenerating culture (De Vierville, 2004). Aquatics is currently used to generate a sense of success, self-confidence, self-esteem, motivation, socialisation, behavioural skills, physical reinforcement, and pleasure (AST, 1992; Wade, 1996; Campion, 1998d; Petersen, 2004). HA using the Ten-Point Programme improves physical skills and thus enhances Global Self-Worth (Harter 1985; 1988; 1999), boosting: social skills, independence, self confidence, self respect and skills, reinforcing learning and personal development, (Martin, 1981; AST, 1992; Morris, 2004; Lambeck et al., 2004; Vargas, 2004). Similarly, WA uses meditation (therapist and receiver) for self healing and total free relaxation combining the rhythms of the brain, breathing, and body itself with motion (Campion, 1998f; Dull and Schoedinger, 2004; Lambeck et al., 2004; Morris, 2004).

Following the RQ toward Verification of Adaptation in Different Domains from the factual to the conceptual stage

The improvement of the children's physical condition during the intervention process and the resultant effects on the children's motivation throughout the different adaptation domains (Harter, 1982; Harter, Whitesell and Kowalski, 1992; Bandura et al., 2001, 2003), can be traced through the sequence of RQ-Figure 2.

The integration of different theoretical models shown in Chapter 2: Table 2, aligns the RQ with ICIDH/ICF (WHO, 1980; 2007), with the Bangma Model (1989), and with White's Model (1987, in Vermeer,1992).

RQ 1 investigated participants' static sitting abilities. Findings indicated that the PIA intervention triggered improvements (Table 2: Horizontally) in Body Functions and Structures (ICF), enabling the participants to overcome the disability of chronic neurological disturbance (Bangma's Model), which increased effective motivation (White's Model).

RQ 2 investigated the participants' functioning in ADL skills in conjunction with HHC. which indicated that the PIA intervention improved functioning activities and participation (ICF, McBurney et al., 2003), so that the effect of the disorder was minimised with improved coordination in motor skills' learning (Bangma's Model). Sitting and coordination skills improvements produced increasingly successful functioning attempts, enabling mastery e.g. bringing chocolate independently to mouth, a new achievement (White's Model).

RQ 3 investigated motor skill competence under different environmental factors (ICF). Findings indicated that the improvement in motor skill competence enabled participants to

improve their PC (Bangma's Model). These improvements triggered further successful skill movement leading to a sense of competence (White's Model).

RQ 4 investigated the participants' level of QOL, and their ability to confront negative personal factors (ICF definition), reducing the participant's negative social role and preventing handicap (Bangma's Model). The findings indicated improvement of the participants social role and minimisation of their social handicap. These achievements led to an improved QOL creating a pleasurable feeling that in turn boosted motivation for participants and their families (White's Model), which was still found to be valid one year post-intervention.

This process is in line with Darwin's biological perception of adaptation that sees the species progressively gaining additional adaptive characteristics (Romanes, 1895).

To return to the consideration of RQ 3: in relation to people with CP, NDT promotes adaptability, by practicing one task to benefit another task, to establish competence, developing motivation, self esteem, self determination and self confidence (Howle, 2004). CE has been shown to improve social interaction of people with CP (Titchener, 1983; Catanese, Coleman, King and Reddihough, 1995; Coleman et al., 1995); and scholastic achievements of those with CP (Heal, 1972; Catanese et al., 1995), scholastic competence (Harter et al., 1992); and cognitive improvement of people with CP (Sigafoos et al., 1993). Both AT and CP have been shown to improve self esteem (Dorval et al., 1996); self perception (Thorpe et al., 2005) social function (Getz et al., 2007) and motivation (Fragala-Pinkham et al., 2009) which all enhance adaptation.

In the present study (as shown in Table 23) increased motor achievements led to improvements in the emotional and psychological domains meaning that the child's enhanced functioning (McBurney et al., 2003) in ADL in turn produced a dramatic improvement in the child's emotional status. This enhanced function illustrates the 'Domino' effect that generated independent improvements in various functional domains following physical improvement even during a period of a lesser proportion of physical intervention (one year post-intervention). It therefore seems that the physical intervention was simply the trigger.

There are many examples of other programmes that enhanced empowerment following physical improvement: (Ozer and Bandura, 1990; Hutzler, 1990; King et al., 2002; Harris and Reid, 2005), CP in AT (Hutzler et al., 1998), improving motivation in NDT (Van Vliet, Sheridan, Kerwin and Fentem, 1995; Bradley, 2000), improving self competence, self efficacy, social acceptance and ADL with CP (Miller and Reid, 2003; Blank et al., 2008), and

improving the self image in NDT (Goldstein, 2004), AT has been shown to improve self image (Peganoff, 1984) and GSW-self esteem (Thorpe and Reilly, 2000), and self esteem on land (Van-der-Burg et al., 2006).

The Black Box Model (Hari and Akose, 1988), IPT, MCLT (Schmidt, 1991; 1992), CE, NDT, DST and WHO, (2007) all suggest that the extrinsic-environment impacts on intrinsic-organism systems and vice-versa (see Table 22, bottom row). The PIA of the present interventions altered the extrinsic environmental factors so that the participants were then able to adjust their functioning and internalise feedback from the environment (Closed Loop) with a positive effect on their intrinsic factors, (ICF, Bangma and White Models) and an improvement in the psychological of self domains: GSW, PC (Harter 1985; 1988, 1999; McBurney et al., 2003; Dickinson et al., 2007) and consequent improved adaptation. This process was then transferred as output, in feed-forward (Open loop), back to the environment (Schmidt, 1991; Howle, 2004; Ricken et al., 2007), a perpetual motion cycle improving body and mind indicated by an enhanced QOL for the participants.

Vermeer (1992) examined the relevance of the application of the Bangma model (1989) to the ICIDH definitions (WHO, 1980). The present research broadened this comparison and included White's model (1987 in Vermeer, 1992), with integration of IPT (Schmidt, 1991; 1992), and ICF-CY (WHO, 2007). This comparison was expressed in the content and sequence of the four RQ. The application and comparison of these four theoretical views to the present research was unique to the present study (see Table 23 below).



**Table 23:**

**Research Questions: Integration Between Theories, Concepts and Models,  
from Factual to Conceptual Levels of Research**

Research Questions



Vertical Level

Horizontal level



Research questions (RQ) constructed a factual level of thinking, coordinating physical and psychological domains in process of adaptation by child with CP	ICF Model	Bangma Model expression of CP condition	White Model Emotional Interpretive level
1 <sup>st</sup> RQ-Factual High	Low	Low	Low
2 <sup>nd</sup> RQ-Factual			
3 <sup>rd</sup> RQ-Interpretive			
4 <sup>th</sup> RQ-Conceptual Low	High	High	High
<div> <div>Extrinsic-environment factors</div> <div> <div></div> <div></div> </div> <div>Intrinsic-'self' personal factors</div> </div>			

## 5.5 Discussion of the Findings relating to Research Question 4

How and why was the QOL of participants with CP altered as a result of the intervention, and at follow-up one year after intervention?

### 5.5.1 Sitting Skills and Psychosocial Improvements expressed in improved QOL were maintained a Year after the Intervention

#### A. Quantitative Findings collected in response to Question 4

The objective quantitative findings strongly support the claim that QOL improved for the children with CP after the PIA intervention in line with the adaptation paradigm. These findings were reinforced by triangulations and replication over four cases using data from six quantitative tools-methods (see Tables: 10 (consideration of Question 4) and 21).

## **B. Qualitative Findings collected in response to Question 4.**

As explained in the previous chapter, the findings relating to QOL were supported by replication/triangulations, comparing qualitative data from NDFI baselines with data triangulation of findings from all quantitative tools (see Tables 11,20,22).

The one-year post-intervention data indicated that sitting skills, which were acquired as a result of the intervention including improved erectness and sitting quality and performance abilities were maintained after this period. Enhanced psychological characteristics of GSW, PC and social skills were also sustained during this period. The parents expressed this as follows: *'You can see the difference, that there is a desire to be more independent... independent in thought... more assertive in thought ... She is not dependant on others. She is not dependent'; 'There is a certain maturity, and in negotiations he has learnt to wait, and not to explode ... He has learnt to be patient in many situations' and 'She has changed, also from a social aspect... Yes there is an improvement in her relationship with her siblings, that is true'.*

The families' recommendations and desire to continue with the therapies which had ended a year earlier, expressed at the follow-up interview, indicated that they had changed their behavioural and therapeutic attitudes and contributed more time to their children with CP, for example: *'So I think that it also made us aware of the importance of making frequent remarks'.*

There were descriptions which indicated closer and healthier family activities and interaction, for example: *'And now we decided to go out on Saturdays, to take him out, and we do this on a permanent basis, and as soon as he bends over, we stop until he straightens up, and this goes on the whole way. I really attribute this to you-Niv [the researcher]'.* **These qualitative findings indicated a sustained improved QOL for the children with CP and their families.**

### The Significance of One-Year Post-Intervention Findings

The one-year post-intervention findings relating to the children's acquisition of sitting skills present fresh evidence relating to a controversial issue. Experimental studies of different intensities of rehabilitative treatment have failed to provide conclusive evidence of preservation of treatment effects over time for people with CP (Trahan and Malouin, 2002).

Some studies of land interventions for people with CP have indicated positive acquisition of motor skills (Gentile, 1987; Bower et al., 1996; Bar-chaim et al., 2006; Charles and Gordon, 2007; Wright et al., 2008), in AT (Getz et al., 2007; Ozer et al., 2007); although other studies produced negative acquisition of motor skills following land intervention (Bower and McLellan, 1992; Bower et al., 2001), and similar findings following aquatics treatment (Hutzler et al., 1998a), though none of these studies conducted one year follow-up over time. Stein and Jessop, (1984; 1991) conducted two randomised controlled trials focusing on

psychological adjustment of children with chronic illnesses (no CP) in an FCS setting versus standard care. Evidence of positive results in these studies were still valid at a 4-5 years, post-intervention follow-up. Verschuren et al. (2007) conducted a randomised controlled trial design involving people with CP, concluding that much of the participants' improvement was partially maintained at a 4-months post-intervention follow-up. Similarly, Charles and Gordon (2007) using an ABABA design in a 12-months follow-up study suggested long-term retention of hand function improvement after intervention on land

A randomised controlled trial by Ozer et al. (2007) relating to AT, found no significant differences, six months after intervention, in competence and behaviours of participants with CP according to teacher or parent reports. In contrast, Dorval et al. (1996) using a non-randomised controlled trial in a nine-months follow-up study revealed the maintenance of significant functional independence for 6 out of 12 adolescent participants with CP following AT intervention. In this latter study Dorval et al. (1996) concluded that when multiple domains or factors and strategies, having equal chances to bring about a change-improvement i.e. with equal causal priority are involved in intervention, this totality can produce change using an FCS within the EA approach (Garbarino, 1990; King et al., 2002; Elder et al., 2007) and this is also provided by DST (Thelen, 1995; Smith and Thelen, 2003; Sugden, 2007).

At a 12-months post intervention assessment improvements of other kinds and from different sources may influence the findings, for example: the child's general development during this period, practice of skills, altered motivation, attention span and alteration in the severity of the CP (Charles and Gordon, 2007). Moreover, *'having a higher physical function does lead [the child with CP] to an increased intensity of participation'* which might have taken place in the present study (McBurney et al., 2003; Verschuren et al., 2007, p.1080).

The one-year post intervention finding seems to support the view suggested by EA-FCS and DST that rehabilitation of people with CP is most beneficial when it involves multivariate domains, factors, fields and strategies, nevertheless the researcher again points out that it was **improvement of one main factor or subsystem (RCPWB) that enabled the children's motor adaptation process and consequent improved functional skills that triggered improved positive adaptation and competence in other domains (Sugden, 2007) and enhanced psychosocial abilities.**

Supporting evidence for this logical process is also provided by the following approaches: in water-AT: Halliwick Approach (HA), (Campion, 1998f; Lambeck et al., 2004), Bad Ragaz Ring Method (BRRM) (Boyle, 1981; Garrett, 1997; Morris, 1997) and Task Type Training

Approach (TTTA) (Morris, 1997; 2004), and on land: (Palisano et al., 2004; Rosenbaum, 2004).

**These findings indicate that the motor adaptation process improved the QOL of children with CP and this was maintained for a 12-month post PIA-intervention. These findings are unique to this research.**

The fact that this enduring improvement in motor adaptation was achieved with the developed PIA and innovative TTC, which enhanced life routines according to an FCS approach, culminating in enhanced HRQOL, constitutes a contribution to knowledge in the clinical field. This was achieved through active participation, specific ADL skills, evidence-based achievements, with intensive and focused practice of independent effective self-sufficient functioning on a basis of daily care and attention (Damiano, 2006; Pirpiris et al., 2006; Charles and Gordon, 2007) and guidance for and involvement of parents.

#### A Change in Parents'/Family Behaviour indicated by Closer and Healthier Interaction,

There is gap-limitation in longitudinal QOL studies relating to stability of achievements over time (Majnemer et al., 2007; Livingston et al., 2007). There is also a lack of investigation of parents' subjective views concerning therapeutic processes for their children with CP and for the family.

The descriptive findings from post-intervention follow-up interviews indicating that the families of the treated children changed their behaviour following treatment for their children is in line with the FCS approach (Rosenbaum et al., 1998; King et al., 2004) within EA (Bronfenbrenner, 1979; Gibson, 1979; Graves, 1995; Gibson and Pick, 2003), involving diverse rehabilitation environments for the child with CP (King et al., 2002; 2004; Perrin et al., 2007; Sugden, 2007).

The therapeutic environment provides opportunities for the organism to detect difficulties and changes while increasing adaptive action by task-oriented mobility so that the child is forced to develop the ability to anticipate and predict the environment (King et al., 2002; Palisano et al., 2004). These abilities enabled physical improvement, supported by SCT (Bandura et al., 2001) expanding personal competencies that play a main role in establishing empowerment (Bandura, 1986; Hutzler, 1990), affecting knowledge, skills, and the child's sense of Perceived Self-Efficacy (PSE) (Ozer and Bandura, 1990). The child was therefore able to employ a variety of adaptative possibilities. Thus applying adaptation of sitting and functioning in ADL specific tasks enhanced the child's PC, one of the main determinants of QOL and a predictor of the child's socio-emotional adaptation (Majnemer et al., 2007; Shelly et al., 2008).

However, the concept of FCS emphasises the influence of parent-child interactions and the need for family and environmental support (Leff and Walizer, 1992; Palisano et al., 2004; King et al., 2004; Wright et al., 2008). The researcher taught parents how to help with their child's treatments, (Diary: 29<sup>th</sup> November, 2005). The continued co-operation of parents also one year after treatment indicated that this activity had empowered them strengthening parents/family resilience, improving their competencies, self-efficacy, capability, and reducing parents' stress, increasing satisfaction and benefiting the child's care (Dunst, Trivette and Boyd, 1994; Trivette, Dunst and Hamby, 1996; Jansen, Ketelaar and Vermeer, 2003; King et al., 2002; 2004).

### Parenting Style

The qualitative finding regarding the improvement of PC should also be seen in the context of different Parenting Styles. FCS indicates that parenting stress has been found to have negative effects on parents' perception of their child's QOL (White-Koning et al., 2007). Therefore, enhancing family coping and reducing stress are critical for improvement of family and child wellbeing associated with psychosocial domains of QOL for children with CP (Aran et al., 2007; Majnemer et al., 2007).

Moreover, when families adapt positively to the disability of their child, the child's adaptive responses are strengthened (Button, Pianta and Marvin, 2001; Magill-Evans, Darrah, Pin, Adkins and Kratochvil, 2001), therefore improving the FCS environment improves child adaptability.

The qualitative descriptions given by the participants and parents confirmed that the physical improvement resulting from treatment improved the children's PC, altering parental attitudes and behaviour, expressed by more effective interaction, leading to closer family interactions and healthier QOL.

**Parents become autonomy-givers. By helping to activate their children's motor function adaptation, they helped to trigger improvement of their children's intrinsic systems (Palisano et al., 2004; Sugden, 2007), subsequently motivating, predicted emotional and psychosocial adaptive aspects, that positively affected the interrelated child's/family's QOL (Aran et al., 2007; Majnemer et al., 2007). This process was recorded in the present research.**

### The Qualitative and Quantitative Findings indicated an Improved QOL for the Children with CP.

Following the conclusions of Waters et al. (2005) and Young et al. (2007): and the WHO (2007) definitions of 'wellbeing' the researcher established *'links [between] quality-of-life concepts and the measurement of subjective well-being'* (p.264). Table 22 identifies and compares categories that emerged from qualitative findings with QOL domains. The table relates to both quantitative and qualitative data according to the progression of the 4 RQ. Total quantitative data was considered in light of the conclusions of Waters et al. (2005) and Young et al. (2007). The definition of 'wellbeing' included an objective physical view of QOL employed in other studies (see Appendix 24): the notion of *'the total universe of human life domains, including physical, mental and social aspects'* (WHO 2007, p.227) appears in the FCS within EA theory that emphasises the value of child and family wellbeing, focusing on improving all domains of QOL (Graves, 1995; Mayston, 2004; Perrin et al., 2007; Rosenbaum, 2008).

The conceptual view of the present study sees improved QOL and HRQOL as indicators of the successful outcome of treatment, constituting the goal of the developed PIA intervention (Moons et al., 2006; Majnemer et al., 2007). Both quantitative and qualitative data (Tables 11, 20, 22 and headlines 4.4.3; 4.4.4 and 4.4.5) revealed an improvement in children's QOL described by themselves, parents and school staff.

The improved physical adaptation indicates that one option to help adaptation of people with CP is to use AT which *'mimics weightlessness'* (Becker, 2004), and RCPWB of buoyancy. The enhancement of the QOL of children with CP by facilitation of the rehabilitation process with PIA using a specially developed TTC-tool, is presented as an innovation of this research. It is supported by Getz et al. (2007) who indicated that *'placing them [the children with CP] in a movement-enabling environment, such as the water, can lead to positive experiences that can affect development in other domains'* (p.226).

## **5.6 Critique: Limitations of the Research**

The researcher's vision in this research was to achieve an improvement in the QOL of children with CP. PIA rehabilitation strategy, applied an improved adaptation paradigm which enabled the researcher to cope successfully with *'the complexity of the problems experienced by children with CP'* (McNeill, 2004, p.133). This complexity necessitated a sophisticated methodology employing an MMD replicated by Multiple Case Study which enabled the researcher to test the PIA process. Despite certain limitations, the researcher confirmed the

fulfillment of the research goals and the consequent contribution to knowledge in the studied field. This section now details possible limitations of the research.

### **5.6.1 Researcher Related Biases**

Research quality is ensured by complying with the principles of validity, reliability and generalisation.

The first problematic issue in this context, is that *'people only see what they are prepared to see'* (Emerson in Patton, 2002, p.260). Yet, what people can see depends on their *'interests, biases, and backgrounds'* (Patton, 2002, p.260). In other words, the reality we all see is based on our understanding of the world, which in turn is based on our knowledge of the self. This impacts on the issue of bias and subjectivity in qualitative research. When using social research subjects, it is far easier to become attached to a certain viewpoint, jeopardizing impartiality. For this reason the researcher took pains to be aware of the possibility of any inherent biases and to minimise the effects of such bias through serious and continuous reflection and meticulous honest reporting of all the research processes and measurements (Mehra, 2002).

### **5.6.2 Social Desirability Bias**

To minimise interviewee 'social desirability' bias (Mason, 1996, p.40), interview bias (Yin, 2003), or face value bias expressed in the respondents' words and/or explanations (Strauss and Corbin, 1998), the researcher followed the assumption that a structured interview guide with standardised order of questions, (Appendix 12) and asked in a uniform manner would stimulate responses that would produce more reliable data (Mason, 1996; Cohen et al., 2000; Morse and Niehaus, 2009).

### **5.6.3 Possible Biases due to Characteristics of the Research Population: Children with CP**

People with CP may be challenged in terms of: perception, intellectual abilities, mental deficits and delay (Abercrombie, 1960; 1968; Levitt, 1995; Stanton, 2002; Bax et al., 2005; Damiano, 2006; Rosenbaum et al., 2007), and may be unable to report information (Bjornson and McLarghlin, 2001; Matza et al., 2004; Varni et al., 2006). The researcher therefore, chose an NDFI tool, using more interviewer control, limiting any discussion, to help interviewees to focus on the question/issue using evocative stimuli to produce better responses (Merton and Kendall 1946 in Cohen et al., 2000), e.g. adopting the suggestion of Wisker (2008) that what has been said should be repeated, while allowing a time period for comparison of bias in answers (see Diary: 29<sup>th</sup>, September, 2005).

Reliability was also reinforced by using '*multiple sources of evidence*' indicated by Yin (2003, p.97) integrating both the participants' self reports and proxy reports by caregivers and parents used by other similar studies (Waters et al., 2005; Varni et al., 2005; 2006; White-Koning et al., 2007).

#### **5.6.4 Sitting Position Assessment Related Biases**

To prevent any possible observation biases and discrepancies, that might result from the use of cameras, tools, the evaluation chair and the TV, the researcher clearly mapped the physical positions of all those tools during measuring (Appendix 15 – Mapping of Sports Hall) ensuring uniformity of findings from these observation tools. The map also enables these settings to be easily replicated to improve reliability in future research in this field.

Speculation arises concerning the measurement of 'improved free sitting quality and balance' as suggested by Reid (1995; 1996; 1997), relating to the reliability of the assessment of seating position and the tools used to measure it. The seating balance was defined and then measured by the ability of the child to shift their body outward and return unassisted to the vertical line (Reid, 1997). Does this process really describe the child's balance ability? The complex evidence generated to claim benefit for the evaluation of the sitting phenomenon has been criticised by some schools of thought and opinions in this field, and some such evidence has been considered dubious (McDonald and Surtees, 2007). The issue is not absolutely clear therefore the present study used a large number of tools-methods both qualitative and quantitative and a variety of triangulations to 'narrow' any possible criticism.

### **5.7 Chapter Summary**

The findings indicating improved adaptive abilities of the children with CP in physical, mental and emotional fields were discussed in light of the research and theoretical literature in the relevant fields. These findings were the result of the factual intervention that modified the environment choosing to RCPWB a sequence of 30mm gradual steps in order to offer children with CP an alternative innovative PIA for rehabilitation. The research focused on MP to improve the children's motor adaptation and ADL functioning, and consequently engendered improvement in their adaptive psycho-social development, which subsequently enhanced other QOL domains. Discussion of this process with reference to the relevant theories reinforced the veracity and usefulness of the study's conceptual framework (Figure 1). Finally the limitations of the research were explained and the ways in which the researcher attempted to overcome them. The next chapter presents factual and conceptual conclusions from this discussion and their implications.



## **CHAPTER 6: CONCLUSIONS**

### **6.1    Precis and Introduction**

The previous chapter discussed the quantitative and qualitative findings of the research following the employment of an innovative PIA intervention for children with CP. It was shown that the MP treatment strategy improved motor adaptation and ADL functioning of the participants and consequently engendered improved psycho-social adaptation and enhanced the QOL of the children and their families. These findings were compared and explained by considering the relevant theories and research findings from extant literature.

This chapter now describes the conclusions drawn from this discussion and possible implications of the research findings, evaluating whether the research has answered the RQ adequately and coherently. As explained in Chapter 1: Introduction, various conditions dictated a relatively small research sample, so that generalisation from the findings is impossible, however implications of the research that may be transferable to other settings-cases or practices are indicated (Morse, 2006a; 2007; Lofqvist et al., 2008).

The research conclusions are presented according to the progression of the RQ. Implications were evident on two levels: the factual and the conceptual levels. The factual conclusions answer the four RQ, explaining how effectively the initial problem (maladaptation of children with CP) was addressed. The conceptual conclusions interpret the factual conclusions or indicate what the factual conclusions mean, explaining their significance.

### **6.2    General Conclusions from the Discussion**

#### **6.2.1   Meeting the Research Goals**

The first goal of the study (examined by RQ 1 and 2-factual level), was to 'reduce gravity', and then by means of RCPWB to gradually reduce buoyancy enabling a gradual return to gravity conditions. This process was facilitated by a specially developed PIA using a unique TTC that enabled the children to improve their motor function adaptation for sitting skills and task movement when performing ADL.

The second goal (RQ 3) was to interpret the implications of these findings concerning motor adaptation improvement and investigate their influence on intrinsic aspects of adaptation such as GSW, PC, PSE, empowerment and motivation.

The third goal of the study (RQ 4-conceptual level), was to investigate the participants' subjective views concerning the intervention and its consequences for their QOL, reinforced by the more objective views of parents and staff. A follow-up study one year

after the intervention enabled processing and conceptualisation of these additional important data-viewpoints that all indicated that the PIA led to an enhanced QOL for participants and their families up to one year post-intervention.

Novel and original findings and understandings of this research and recommendations for further research are indicated in bold type following the relevant conclusions.

### **6.3 From Buoyancy (unloading) to Gravity (loading) Conditions: Regulation, Control and Gradual Progression develop Motor Functioning and Sitting Adaptation: Factual Conclusions**

#### **6.3.1 RQ 1 and 2: Interventions employed to facilitate motor function adaption of ADL**

The factual conclusion from the quantitative findings is that treatment provided in an AT (water) environment was the most efficient intervention for improving the children's sitting and functioning. While a combination of water and land environments produced the highest results, a calculation for treatment in a land only environment demonstrated the lowest results.

It was concluded that the combined water and land intervention (gradually reducing buoyancy in 30mm transitional steps) significantly improved the participants' ROM and thus contributed greatly to quality and balance of at rest and reach free sitting.

**This novel intervention and its positive influence is presented as an innovation of this research.**

The findings from the triangulated data demonstrated that the application of twelve selected research principles for this study, together with an innovative TTC in gradual steps of 30 mm max 'gravity' loading to form a developed PIA rehabilitation therapy which was implemented in alternate treatments of SPT and ADLSF four times per week engendered enhanced motor sitting and functioning adaptation.

**The developed PIA including the application of twelve principles and RCPWB using TTC in steps of 30 mm max gravity loading constituted an innovation of this research.**

It was found that the PIA, enhanced functioning ability by controlling the relationship of buoyancy and gravity; this improved the relationship between the support surface contact and the child's functioning ability, enabling the child with CP to generate movement from this surface point.

**This conclusion regarding the benefit of the support surface contact with this particular type of PIA using the TTC has not been previously documented in the literature and constitutes a contribution to extant knowledge on this issue.**

It was also concluded that the PIA enabled the researcher to use RCPWB to produce different therapeutic environments and that this strategy helped to regulate and control feedback enabling anticipatory adjustments and therefore improved feed-forward and sitting behaviour performance.

**This highly sensitive RCPWB in water environment is presented as an innovation of this research.**

The interview findings showed that the total intervention process empowered the children during their sitting in an AT environment and during transition of these skills to land. **This appears to be a unique achievement of the PIA used in this research.**

It was also found: that controlled water/land environments enabled the exploitation of more 'closed' and 'open' environments, developing different gradually more challenging fields while supporting sitting balance and preventing the children with CP from falling. **The success of this strategy is presented as a unique achievement of this research.**

### **6.3.2 RQ 3: Motor Adaptation engenders Adaptations in other Domains**

It was concluded that improved motor function adaptation of the children with CP triggered improved adaptation in other domains and fields, a concept that was suggested in the Conceptual Framework of this study (Figures: 1 to 4).

The developed PIA involved the consideration of multivariate domains, systems, factors, and fields (in accordance with the theories of EA and DST) nevertheless it was concluded that one main parameter triggered or influenced all other systems to develop and improve the general adaptation process for the child with CP: the motor functioning system (Figures: 3, 4).

**This conclusion indicates a new direction in AT thinking, i.e. identification of a single main cause for systems change and application of this conclusion in therapy: in this specific cases RCPWB by 30mm. maximum was identified as the singular main cause for the child's improved motor adaptation to its environment and this motor function adaptation subsequently led to an improvement in the child's overall adaptation and QOL.**

Findings also indicated that PIA treatment that applied different approaches (NDT, CE and AT) in combined environments for children with CP in a gradual progression from water to land environment produced an improvement in psychological domains of the self (Harter, 1999).

**This conclusion was unique to this research and is not mentioned in other sources relating to combined environments treatments for children with CP.**

It was shown that the PIA extrinsic intervention environment produced motor adaptation input and triggered a process of change according to the graduated stages of three models: (ICF, Bangma and White) engendering change in the adaptation of intrinsic systems. This process was transferred as output back to environment, as the children's improved self-concept, PC, and motivation and helped to positively influence their environments and thus reinforce and sustain therapeutic achievements.

This input-output process, is a parallel concept to that expressed by Juvenal (1999, 55 to 127 AD), '*A healthy mind* [intrinsic component is influenced by] *in a healthy body*', a process initiated by the beneficial extrinsic PIA intervention.

**This application of the Black Box Model and IPT integrated with the above-mentioned three models (ICF, Bangma and White) provided a broader frame of reference for the present research than the application of Bangma's model to ICIDH categories performed by Vermeer (1992) that may be useful for future research in this field.**

#### **6.3.3 RQ 4: PIA Improves QOL**

It was concluded that the applied PIA's influence on motor adaptation in an AT environment improved QOL for the children with CP and also for their families. This was expressed in both quantitative and qualitative findings.

There is no mention of improvement of the QOL of children with CP as a result of treatment in an AT environment in the extant literature, and the present research appears to be the first to record this achievement.

**The fact that the PIA used in the AT-water and land environments intervention applying integrated NDT and CE treatment approaches yielded QOL improvements for children with CP, also appears to be an achievement unique to this research.**

The findings also indicated that the application of the PIA according to the principles of the adaptation paradigm facilitated the improvement of the participants' adaptation in AT, which was then carried-over to land, and continued to positively influence the QOL of the participants at the follow-up assessment 12 months after the intervention.

**This conclusion regarding the endurance of improved QOL one year after the intervention was unique to this study.**

### Proposition for Future Extended Application of the PIA

It was concluded that the PIA strategy used in the present research for children with CP is most practical and beneficial when unloading toward loading is used and not the opposite. The participants' initial physical state (GMFCS level IV) did not allow them to sit independently, or to function on a stool on land. RCPWB using water-buoyancy supported independent sitting and facilitated ADL functioning in water which was then carried-over to land.

**It is possible that this particular PIA may also facilitate more advanced sitting abilities or treatment of other CNS impairments which were outside the scope of the present research aims. Further studies may explore this possibility.**

## **6.4 Improving the QOL of Children with CP: A New View of PIA-Conceptual Conclusions and Implications**

### **6.4.1 RQ 1 and 2: Interventions employed to facilitate motor adaption in ADL functioning.**

The findings led to the conceptual conclusion that variables of water heat positively affected the participant's body (WHO, 2007, p.87). For example:- the heat of the water enhanced by its relaxing qualities, induces and helped to reduce hypertonus and hypertonicity (Lepore et al. 1998; Hutzler et al., 1998a; Bennie, 1998; Kesiktaş et al., 2004) specifically for children with CP (AST, 1992; Bergman and Hutzler, 1996; Hutzler et al., 1998a), enabling the children with CP to increase their ROM (Peganoff, 1984; Shelef, 1998; Vogtle et al., 1998; Fragala-Pinkham et al., 2009).

It seems from the findings that the AT (water) environment PIA intervention for children with bilateral spastic CP (GMFCS level IV) may have constituted an essential stage before land therapy was used and facilitated initial adaptation in water that was afterwards carried over to land.

The research findings also indicated that the AT environment used in this research has potential to prevent fear of falling in water, an achievement which can then be carried over on to land. Secondly, PIA empowerment increased the participant's adaptation ability, which also contributed to fear reduction and thus enhanced participants' QOL, which was the aim of the intervention.

**It was concluded that regulation of the force of buoyancy to counter gravity, by RCPWB, using the TTC, facilitated the rehabilitation for children with CP (GMFCS level-IV) in the AT environment.**

It is therefore recommended that similarly developed tools like the 'TTC used in this research could be used for other balance activities, e.g. standing, walking, and to treat other CNS disorders, conditions or disabilities.

#### **6.4.2 RQ 3: Adaptation engenders Adaptations in other Domains**

It was concluded that the use of the innovative tool: TTC constituted a trigger for human development.

**The participants enhanced their motor adaptation leading to improved adaptation in other domains. This was the 'wisdom' derived from the present research and constitutes a contribution to extant knowledge on human adaptation.**

Research results affirmed that '*movement and posture*' is the principal limitation for people with CP and constitutes both the 'core' and also the 'cure' in any agenda designed to improve motor adaptation and consequently to rehabilitate and improve HRQOL and QOL of the child with CP.

The results also showed that the innovative development of a fourth environment for rehabilitation: a transition zone between water (unloading) and land (loading) environments (Chapter 2: 2.4) enabled participants for the first time to enjoy greater participation and '*involvement in a life situation*' (WHO, 2007, p.xvi; Wright et al., 2008). This achievement of improved adaptation fulfilled the expectations outlined in the conceptual framework of this research (Figure 1).

#### **6.4.3 RQ 4: PIA Improves QOL**

On the conceptual level, the conclusions that emerged from the various triangulated findings in response to RQ 4 confirmed the prediction of the research's conceptual framework that improvement in the children's motor and ADL functioning adaptation would improve their QOL. The developed PIA treatment produced an improvement in the children's QOL that was still evident 12 months after the intervention was completed.

### **6.5 MMD with Replication logic investigated the effect of an applied PIA Intervention on the Adaptation Process of Children with CP**

Figure 10 below traces the process of adaptation that the research participants underwent as it was described through the responses to the RQ. At the factual level (RQ 1 and 2) the use of an innovative PIA and TTC incorporated AT-water approaches with NDT and CE clinical rehabilitation approaches and their associated theories. This therapeutic intervention

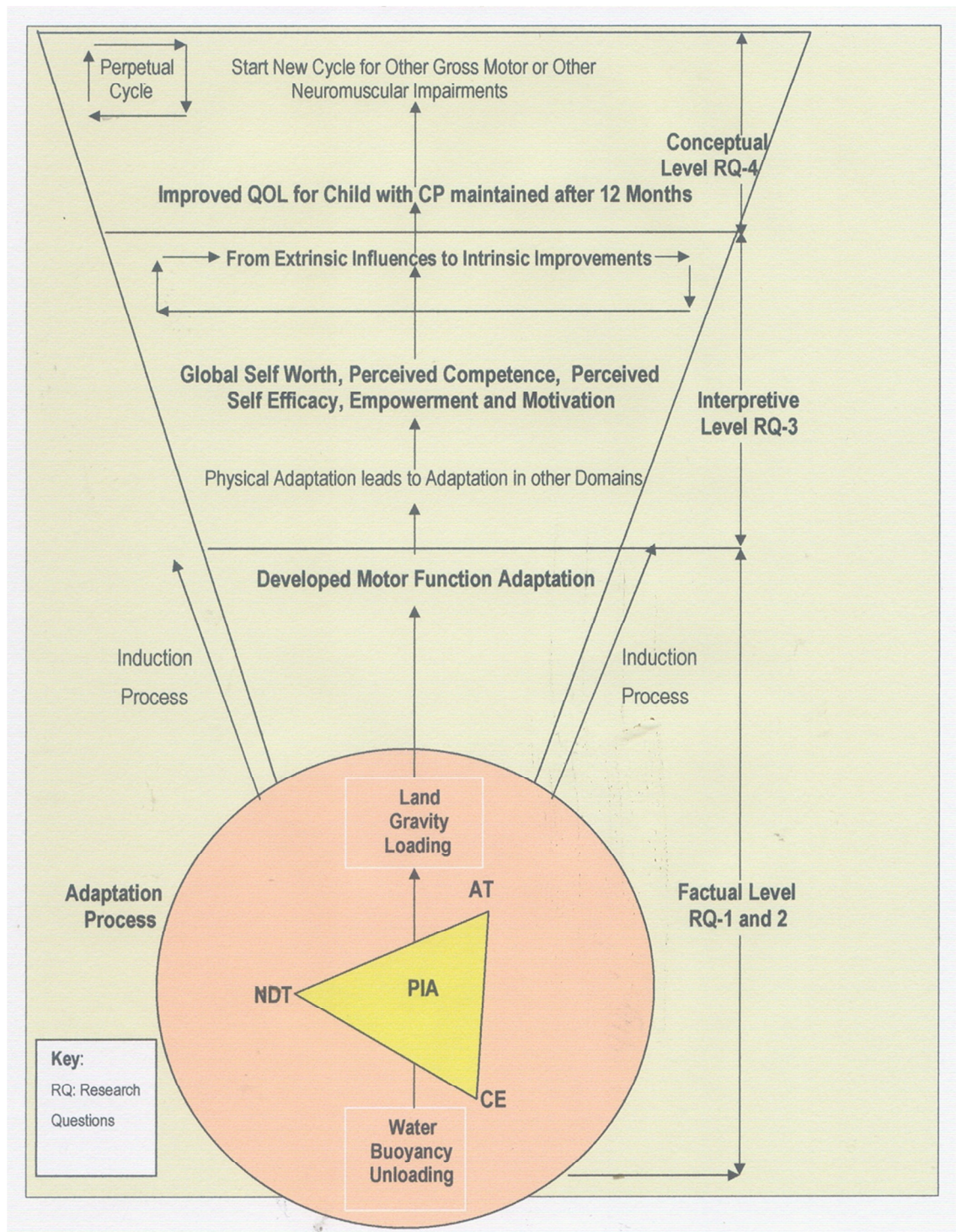
took place within the conceptual framework of the adaptation paradigm, relating to the maladaptation of children with CP.

The implications of findings that revealed improvements in the children's motor adaptation improvement were then interpreted (RQ 3). This interpretation led the researcher to investigate whether there had been a consequent improvement in other psychosocial domains for the children, indicating that extrinsic influences produced intrinsic improvements, which in turn formed a repetitive cycle. Concetualising these findings the research examined (RQ 4) whether this process had led to an improvement of QOL for the children with CP and for their families.

**The improvement of QOL for participants and families was a result of their improved adaptation to their natural environment. This constitutes a contribution to knowledge in the fields of knowledge relating to physical rehabilitation and adaptation.**

Figure 10 below illustrates the process by which the children with CP improved their adaptive abilities with the assistance of the applied PIA-intervention.





**Figure 10: Improved Adaptation of Children with CP examined through the Research Process Stages**

## 6.6 Chapter Summary

This chapter traced the research process through its various stages, indicating the conclusions which were drawn from the collected data. The conceptual framework of the research proved to be appropriate for the examination of the studied issue and it was shown how the RQ yielded the necessary information to address the identified gap in knowledge. It



was shown how the innovative developed PIA facilitated the improvement of motor functioning of children with bilateral spastic CP, and consequently improved their psychosocial functioning and their QOL. Novel findings of the research were indicated. Certain recommendations were given for future research directions. The next chapter summarises five main contributions by this study to various fields of extant knowledge.

## CHAPTER 7: THE CONTRIBUTION TO KNOWLEDGE

### *Precis*

The previous chapter explained the conclusions of this research regarding the application of the innovative PIA, which formed different types of environment for the research interventions. The transition between the environments altered the conditions of the treatments, facilitating the participants' abilities to enhance their motor sitting adaptation. This chapter indicates the contributions of these conclusions to extant bodies of knowledge.

### **7.1 Introduction**

In general, the study's contribution is based on the effective application of an innovative PIA by means of a specially designed TTC, in order to RCPWB a gradual reduction in buoyancy in steps of 30mm maximum. Improved motor adaptation of the children's MP facilitated by this process also engendered adaptations in other domains thus improving QOL of participants and their families. However, certain study limitations detailed in Chapter 1: Research Problems, restrict empirical generalisation of the research conclusions.

The present research journey yielded significant rewards. The review of theoretical and research literature underlined the view that people with CP experience secondary impairment of their MP because of their maladaptation to their environmental gravity conditions, the researcher therefore decided to adopt an adaptation paradigm, and strove to improve adaptation through the research interventions. A gap was noticed in knowledge, relating to the therapeutic properties of the RCPWB technique for children with physical disabilities, in light of the fact that gravity-Weight Bearing has beneficial effects on MP of the earth's fauna and flora. It was decided to apply the adaptation paradigm to AT treatment employing RCPWB to facilitate motor functioning of children with bilateral spastic CP. On the face of it, it might be assumed that AT, including rehabilitative treatment in mixed water and land environments is a purely physical remedial process and does not appear to offer any substantial improvement in QOL for children with CP. However this was an assumption that the present research examined and disproved.

The research conclusions contributed the following knowledge to reduce the identified gaps in extant knowledge in relation to five subjects:

- Regulation of buoyancy-'gravity' by RCPWB in a gradual progression of phases of 30mm. maximum from unloading to loading facilitates motor adaptation of children with CP.

- The development of motor adaptation by improving motor functioning of children with bilateral spastic CP engenders adaptations in other human domains.
- AT and land therapy conducted according to a specially developed PIA produced an enhancement of QOL for children with CP that endured up to 12 months.
- Three innovative measurement tools were developed as part of the PIA process to produce clinical rehabilitative benefits for sitting and functioning of children with CP.
- Using 'analytic generalisation' (Firestone, 1993; Yin, 2003; Shkedi, 2005), it is possible to indicate the possibility of 'stretching' existing theories with the proposed PIA and TTC toward a realistic and effective treatment model for children with CP.

## **7.2 Regulation and Control of Buoyancy**

People with CP have difficulty adapting their sitting to gravity conditions on land. The PIA process tested in the present research provides a new set of transitional treatment environments, by regulating buoyancy in a series of 30mm progressive steps that gradually decrease the child's immersion in water. This process facilitates the gradual autonomous adaptation process of children with CP in their transition to gravity conditions on land.

The achievement of this sensitive progression enlarges on previous techniques and proved to be easier to use for both therapist and child with CP than similar strategies mentioned in therapeutic and research literature in which the child's is moved from the deep to the shallow part of the pool in order to reduce buoyancy effects (Morris, 1997; Campion, 1998e; Maynard, 2004; Morris, 2004), which neglect sensitive regulation and control of buoyancy and are based on gross progression strategies unsuitable for the characteristics of the particular study participants in this research (see Appendix 2: figures: 2, 6 and 11 (2-11)). It is suggested that innovative tools developed on the model of the TTC used in this research could be employed in AT to facilitate the improvement of other gross motor functions and for other neuromuscular impairment populations.

## **7.3 Motor Adaptation engenders Adaptations in other Domains**

Previous AT interventions that, like the present study, combined water and land treatments neglected the effects of this physical therapy on the participant's self domain. The determination of Bax (1964, p.295) that a defect in '*movement and posture*' is the defining characteristic of CP proved useful as a basis for rehabilitation. It formed the foundation for the use of RCPWB in the present research intervention to improve motor adaptation and constituted the basis for the conceptual framework assumption that application of this

strategy (RCPWB-manipulates MP) according to an adaptation paradigm would also improve adaptation in the participant's psychosocial domains.

In line with the principles of IPT, asserting that alteration of extrinsic variables impact on intrinsic variables creating an incessant cyclic reaction, the present research used the extrinsic variable of RCPWB to facilitate adaptive change (Darwin, 1958; Maguire and Sutton, 2005) in the participants' physical functioning that, in turn, engendered change in intrinsic systems of children with CP, affecting psychosocial aspects of their 'self', and consequently producing a holistic enhancement of the children's QOL.

The inquiry's conceptual framework combined the clinical rehabilitation approaches of NDT, CE and AT with the above-mentioned principles of IPT (BBM) - the influence of the extrinsic environment system on the intrinsic individual's intrinsic systems - as the underlying conceptual foundation for the innovative PIA with 'TTC'. This constitutes a complex conceptual mix that has not been used in previous rehabilitative work. It is suggested that this combination of theories contributes a useful conceptual basis for further rehabilitative research in this field.

#### **7.4 PIA enhanced QOL for the Children with CP and their Families**

The investigation of the effect of AT (in either water environments or in combined water and land environments) on the QOL of participants (and their parents) through subjective reports has not been previously reported in the research literature. Consequently, there have also not been follow-up studies relating to participants' QOL some time after the termination of AT. This investigation was undertaken by the present research. This assessment of QOL and HRQOL constitutes an important indication of the effectiveness of any therapeutic intervention. It is even postulated that improved QOL resulting from such intervention may positively affect life expectancy, indicating a future direction for further research so that it is therefore recommended that improved QOL should be one of the goals of any future PIA clinical intervention.

The philosophy underlying the PIA employed in this research with its special facilitating environments may have serious implications for the development of physical impairment rehabilitation. Therapy in such facilitating environment conditions should begin on a daily basis at an early age, for example it is possible to envisage a dining room, class room, bathroom or kitchen for young children with CP assembled in water. Thus too, participants could practice functioning in a swimming pool with a hydraulic moveable floor, facilitating a progression from unloading toward loading in 20-30mm steps to improve motor adaptation,

psycho-social development and consequently QOL improvements that could later be carried over gradually to the participants' natural environment on land.

## **7.5 Tools Development**

There is a lack of assessment tools for the evaluation of appropriate sitting with HHC that enables functioning while sitting. Development of suitable assessment tools contributes to therapy for beneficial sitting and to the improvement of functioning diagnosis for impaired populations.

In the present research all the following assessment tools were adapted and enhanced to serve the purposes of the research. Data were collected in relation to the participants' free sitting, balance and ADL functions in conjunction with HHC. Goniometry used to evaluate hips' ROM verified the participants' equilibrium, indicating improved balance while sitting (Reid, 1997). The Interval Recording Observation (IRO) tool verified the best trunk position relative to the line of gravity (Myhr and von Wendt, 1991; McClenaghan et al., 1992), i.e. 90° to the floor. The Rating Scale ADL Observation Test (RSADLOT) tool verified the improvement of participants' ADL functioning during free sitting in conjunction with improved HHC. Construction triangulation reinforced the validity of these findings (Stake, 1995; 2000; Cohen et al., 2000; Yin, 2003). All these tools underwent special modification for the purposes of the present research and for the needs of the relatively severely disabled research population (see details in Table 5: No.3,5,6; figure 6 and Appendices 16,17,18). These developments may be useful for application by other researchers in this field.

Functioning and motor abilities were assessed after treatment with the PIA using RCPWB according to CP classification categories e.g. GMFM (Russell et al., 1993) total score between 19% and 34% and GMFC level IV (Palisano et al., 1997). These measurements indicated that the use of the TTC to decrease buoyancy by 30mm (max) once a week, including 4 treatments of SPT and ADLSF per a week for a total of 40 treatments produced an obvious improvement in the level of impairment due to CP and consequently in QOL that was maintained (according to quantitative and qualitative data evidence from interviews with the participants and their parents/care-giver) 12 months after the last treatment. This achievement was unique to the present research and indicates the effectiveness of the innovative PIA used in this study. Additionally, the proposed PIA offers the possibility of conducting a pre-intervention physical assessment and/or psychosocial assessment for rehabilitation in changing environmental conditions based on the new PIA- techniques (regulated 30mm steps gradually decreasing buoyancy) and both the above mentioned tools (IRO and RSADLOT).

## **7.6 Analytic Generalisation**

The long journey of the present research also yielded insights and conclusions that may add to and enrich the underlying theories on which the conceptual framework of the thesis was constructed.

## **7.7 Motor Control and Learning Theories**

Improved abilities of motor control and motor skills learnt and acquired in a water environment were gradually transferred/carried-over to a land-gravity environment. The PIA treatment programme was used to regulate and control feedback in the present research, with improved feed-forward. This strategy can be applied to improve hand-to-head coordination in disabled populations, and in the training of healthy athletes, or to enhance other gross motor functions (using training in AT with facilitating tools similar to the TTC) e.g. standing, walking, running and throwing activities in track and field and ball games activities.

## **7.8 The Appropriate Environment for Rehabilitation**

Following the principles of the Ecological Approach, the research demonstrated that the control of buoyancy/gravity conditions in a sequence of 30mm maximum phases, was more effective to facilitate motor development in water PIA than in a land environment with unmoderated gravity conditions. This might have implications regarding the choice of the appropriate environment for rehabilitation of populations with CNS impairment.

## **7.9 System Theory**

EA, DST and development theories argue that a variety of systems and principles, are involved in any change engendered by a rehabilitation programme for people with disabilities. However, the present research identified a single cause for systems change: the reduction of gravity conditions (in line with theory regarding Degrees of Freedom) that were then gradually increased through RCPWB facilitating motor function adaptation. The improvement in the motor system consequently affected all other (psychosocial) sub-systems eventually enhancing the overall system to ensure an improved QOL for the participants and their families. This conclusion contributes new understanding concerning the significance of gravity for human adaptation and functioning.

The fact that this facilitating process for physical adaptation also positively influenced humans' emotional state and self-confidence (D'Amato et al., 2005; Elder et al., 2007) leading to enhanced self-concept and improvement of PC-motivation has implications

beyond the rehabilitation of the disabled and may be applied to sport science, in relation to such psychological aspects as the motivation and mental ability of sportsmen to achieve goals and win competitions.

### **7.10 Combination of Three Models ICF, Bangma and White**

One of the conclusions of the present research was that the PIA extrinsic factual intervention input triggered a process of change, which enhanced the functioning of intrinsic emotional systems of the self, the GSW, PC, PSE and self empowerment that could be aligned with the graduated stages of three models: ICF, Bangma and White.

The IPT (BBM) theory (as applied to the research process) was aligned with the categories of the above-mentioned three models (WHO, 2007; Liptak, 2008; Wright et al., 2008) to provide a broader frame of reference for the present research than the application of Bangma's model to ICIDH categories conducted by Vermeer (1992). This combination of theories and models may provide a useful conceptual framework for future research in rehabilitation in the fields of criminology, sociology and psychology with different populations and contexts.

### **7.11 The Theory of the Origin of Species (Darwin 1958)**

In his classic theory of evolution, Darwin stated *'I am convinced that natural selection [adaptation] has been the main, but not the exclusive means of modification'* (Romanes, 1895, p.5). The conclusion of the present research that improved physical adaptation enhances adaptation in other human domains: the emotional state in the self domain-PC (Harter, 1978a; Harter, 1982; Harter, 1985; Harter and Chao, 1992; Harter et al., 1992; Getz et al., 2007), PSE: a sense of empowerment (Bandura, 1986; Hutzler, 1990; Bandura et al., 2001; 2003) and motivation, confidence, competence and self esteem (Tsur, 1997; Howle, 2004; Brown, 2005; Maguire and Sutton, 2005; Taylor et al., 2007) provides an additional perspective on Darwin's classic theory.

It is hoped that the conclusions of the present research may provide inspiration and enrichment to others who are involved in the rehabilitation of challenged populations with disabilities; readers are invited to verify the applicability of these conclusions to their own research and therapeutic needs (Stake, 1995; Firestone, 1993; Merriam, 1998; Shkedi, 2003; Wisker, 2008).

## EPILOGUE

### A. Post- Adaptation Appreciation

The sum result of my immense research efforts and my own adaptation to the world of research is that I have established that the application of the RCPWB process employing my specially designed TTC within my proposed PIA was able to gradually decrease buoyancy in phases of 30mm enabling an unloading toward loading process. This process facilitated an improvement in the motor sitting adaptation of children with CP and consequently engendered improved adaptation in other psychosocial domains contributes to their QOL up to one year time. This achievement produced real and tangible benefits for the children who participated in my research.

However, for me, the emotional experience of writing this final conclusion resembles the emotional reactions that I witnessed in the children, who underwent this exploration with me, my research participants when they accomplished their improved functioning and were able to subsequently participate more fully in their families and environment and with better QOL.

My learning disabilities inspired me to pursue this journey and to overcome my limitations, and, at the same time, they also helped me to be sensitive to and understand the limitations that the phenomena of CP imposed on the participants. Although the CP condition may be very traumatic for those affected by it, reflection on this phenomenon led me to greater understanding of the meaning of life and the way in which humans exist on this earth, in particular the adaptation of the human to the environment.

The masterpiece of Darwin's work, *The Origin of Species* stands out today (out of many which are less authentic), as it stood out when Darwin and Wallace wrote their joint paper on July 1<sup>st</sup>, 1858 (Darwin, 1958). This delightful and inspired theory provides the basic 'cornerstone' for the understanding of life of any flora or fauna in our world. For those who are curious and studious enough to delve within its pages, it offers clarification and elaboration of the simple concepts of 'life' or 'death'. In this present journey I chose to relate to Darwin's consideration of 'life'. Darwin *'asked himself which individuals survive and procreate? Obviously, those whose variations represent a better adaptation to environment. Nature breeds a vast oversupply of experiments and then sterilizes the failures by murdering them'* (Irvine, 1955, p.76). The 'cut line'-the fine border-line between adapt-survive or die-extinct is very clear, but even more, Darwin's theory offers the effective tool of the adaptation paradigm which philosophically constitutes



the difference between live or death for children with CP. It is this paradigm which must be applied within the practice of scientific method to the most e.g. this research, to provide maximal assistance for this population to improve their adaptation, their life quality, experience and consequently perhaps even their life expectancy.

## **B. The TTC Patent**

The TTC was invented and constructed specifically for the PIA used in the present research. Negotiations and procedures for the receipt of a patent for this invention were conducted together with the assistance of the attorney, Dr. E. Luzzatto.

For a private researcher like me, the expenses involved in obtaining a patent are extremely high. However, Luzzatto and Luzzatto Patent Attorneys, Israel conducted a review of the relevant patent literature in October, 2005 and found no device similar to the TTC that could be used with the same specific aim of developing motor adaptation of children with CP in an AT setting (Diary: 26<sup>th</sup> October, 2005).

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